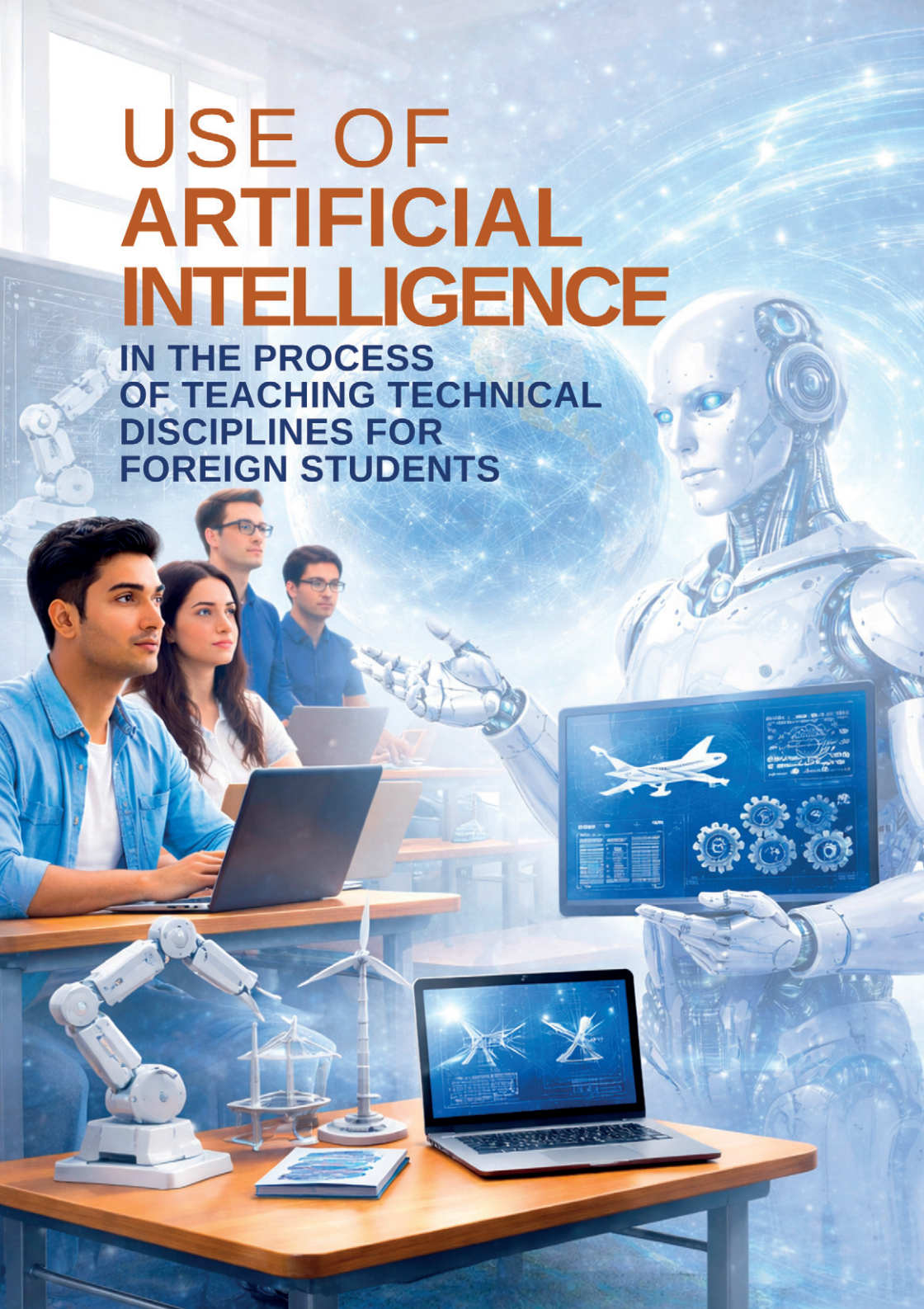
USE OF ARTIFICIAL INTELLIGENCE

IN THE PROCESS OF TEACHING TECHNICAL DISCIPLINES FOR FOREIGN STUDENTS



MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
Admiral Makarov National University of Shipbuilding

USE OF ARTIFICIAL INTELLIGENCE TEACHING TECHNICAL DISCIPLINES FOR FOREIGN STUDENTS

Methodological Recommendations

Recommended for Publication by the Academic Council of the Admiral Makarov National Shipbuilding University

Mykolaiv
«Ilion»
2026

UDC 378.147:004.8(072)
U 88

A U T H O R S :
I. BILIUK, Candidate of Technical Sciences, Associate Professor;
I. NADTOCHII, Doctor of Economics, Professor;
A. NADTOCHIY, Candidate of Technical Sciences, Associate Professor;
G. MYKHAILOVA, graduate student;
A. KOZLOV, PhD; A. IVANOV, PhD

R E V I E W E R :
A. M. MUKHA, Doctor of Technical Sciences, Professor, Head of the Department of Electrical Engineering and Electromechanics Ukrainian State University of Science and Technology

Recommended for Publication by the Academic Council of the Admiral Makarov National Shipbuilding University (Minutes № 4 dated 30.04.26)

Use of Artificial Intelligence in the Process of Teaching
U 88 Technical Disciplines for Foreign Students : Methodological Recommendations / I. Biliuk, I. Nadtochii, A. Nadtochiy and others. — Mykolaiv: Ilion, 2026. — 112 p.

ISBN 978-617-534-790-4

Methodological recommendations are devoted to the issues of using artificial intelligence in the process of teaching technical disciplines for foreign students using the example of specialties G3 «Electrical Engineering» and G7 «Automation, Computer-Integrated Technologies and Robotics». The publication considers modern approaches to integrating artificial intelligence tools into the educational process, taking into account didactic, methodological, ethical and regulatory requirements. The methodological recommendations analyze the peculiarities of teaching foreign students of technical education, outline the methodological possibilities of using artificial intelligence when teaching theoretical material, organizing practical and independent work, as well as monitoring and evaluating learning outcomes. Particular attention is paid to the issues of academic integrity, responsible use of digital technologies, and preventing the risks of unethical use of artificial intelligence in the educational process. The methodological recommendations are addressed to teachers of technical disciplines in higher education institutions, methodologists, developers of educational programs, and may also be useful to administrative staff responsible for ensuring the quality of education, and foreign students in order to form a conscious attitude towards the use of artificial intelligence tools in educational activities.

UDC 378.147:004.8(072)

ISBN 978-617-534-790-4

CONTENT

INTRODUCTION

The modern development of the higher education system takes place in conditions of rapid digitalization, globalization of the educational space and active implementation of innovative information and communication technologies. One of the key factors of these transformations is the emergence and spread of artificial intelligence technologies, which are increasingly being used in various spheres of public life, in particular in education. The use of artificial intelligence opens up new opportunities for the modernization of the educational process, increasing its flexibility, adaptability and efficiency, especially in the field of teaching technical disciplines.

Technical education plays a decisive role in training highly qualified specialists for engineering, industry, energy, information technology and other sectors of the economy. At the same time, teaching technical disciplines is characterized by a high level of complexity of educational material, a significant proportion of abstract concepts, formalized models and specialized terminology. These features significantly complicate the educational process for foreign students who, in addition to mastering professional knowledge, are forced to adapt to a different language environment, cultural characteristics and differences in previous educational training.

These problems are of particular relevance in the context of training foreign students in the G3 and G7 specialties, which belong to the technical and engineering branches. These specialties are characterized by increased requirements for the level of mathematical training, logical thinking, the ability to analyze complex technical processes and work with large volumes of specialized information. Under such conditions, traditional teaching methods do not always provide a sufficient level of accessibility and effectiveness of educational material for foreign students.

Artificial intelligence in the process of teaching technical disciplines can play the role of a powerful auxiliary tool aimed at supporting the educational activities of foreign students. In particular, AI tools are able to provide adaptive presentation of educational material, automated translation and explanation of terms, personalized learning pace, interactive support during practical and calculation tasks, as well as promote the development of independent work skills. At the same time, the effectiveness of the use of such technologies largely depends on the level of methodological training of the teacher and the availability of clear recommendations for their use.

Along with the potential benefits of using artificial intelligence in the educational process, a number of challenges arise related to compliance with the principles of academic integrity, ethical standards, and current regulatory and legal regulations. Uncontrolled or unconscious use of AI can lead to the replacement of personal intellectual activity with automated results, a decrease in the level of critical thinking, and the formation of dependence on algorithmic

solutions. For foreign students, these risks are exacerbated by language barriers and the difficulty of independently verifying the generated information.

In this regard, the issue of methodological support for the use of artificial intelligence in the educational process is of particular importance. A teacher of technical disciplines must not only possess modern digital tools, but also clearly understand the limits of their permissible use, ways of integrating AI into educational tasks, and mechanisms for controlling the independence and responsibility of students. It is the methodological recommendations that are intended to become a tool for generalizing best practices and regulatory requirements in this area.

The purpose of these methodological recommendations is to provide teachers of technical disciplines with systematized, scientifically based and practically oriented recommendations on the use of artificial intelligence in the teaching process for foreign students of G3 and G7 specialties, taking into account didactic, methodological, ethical and regulatory aspects.

To achieve the goal, the methodological recommendations provide for the solution of the following tasks:

– outline modern approaches to the use of artificial intelligence in the educational process of higher education institutions;

– to determine the features of training for foreign applicants for technical specialties;

– to reveal the methodological possibilities of applying AI when teaching technical disciplines;

– analyze the potential risks of unethical use of artificial intelligence and ways to prevent them;

– provide practical recommendations on organizing the educational process using AI tools.

The methodological recommendations are addressed to teachers of technical disciplines of higher education institutions, methodologists, developers of educational programs, and can also be used by administrative employees to form internal policies and regulations on the use of artificial intelligence in the educational process. The materials of the manual can also be useful for foreign students in order to form a responsible and conscious attitude towards the use of digital technologies in education.

SECTION 1. THEORETICAL AND METHODOLOGICAL BASIS OF THE USE OF ARTIFICIAL INTELLIGENCE IN EDUCATION

1.1. THE CONCEPT AND ESSENCE OF ARTIFICIAL INTELLIGENCE IN AN EDUCATIONAL CONTEXT

Artificial intelligence (AI) in modern scientific and educational discourse is considered as a complex multi-level concept, encompassing both theoretical foundations and applied technologies aimed at modeling, reproducing and expanding human intellectual activity using computer systems. In a broad sense, AI is defined as a set of methods, algorithms and software and hardware capable of performing intellectual functions, such as information perception, its analysis and interpretation, data-based learning, logical reasoning, forecasting and decision-making.

In a narrow, applied sense, artificial intelligence in education is interpreted as a class of digital tools that use machine learning, neural networks, natural language processing, and data mining methods to support the educational process. A distinctive feature of such systems is their ability not only to process information according to predefined algorithms, but also to adapt their behavior based on the analysis of the results of interaction with the user.

In the context of higher technical education, artificial intelligence should be considered as a pedagogical support tool that complements traditional educational methods and modern information and communication technologies. Unlike classical ICT, which mainly provide storage, transmission and visualization of educational information, AI is focused on intellectual interaction with the student, analysis of educational actions and formation of personalized recommendations.

The essence of artificial intelligence in the educational process is manifested through the performance of a number of key functions. First, information and analytical, which consists in processing large volumes of educational and scientific and technical information. Second, adaptive, which ensures the adjustment of educational content to the individual level of training, learning pace and language characteristics of education seekers. Third, consulting, which is implemented in the form of explanations, tips and examples when solving educational and practical tasks.

For the Admiral Makarov National Shipbuilding University, an engineering-oriented interpretation of artificial intelligence is fundamentally important. In this aspect, AI cannot be considered as an autonomous substitute for a teacher or a carrier of engineering knowledge, but acts as an intellectual assistant that contributes to better mastering of complex physical, mathematical and technical concepts. This is especially true for disciplines of electrical engineering and automation, where cause-and-effect relationships, system analysis and the correct application of mathematical apparatus play a key role.

An important aspect of understanding the essence of artificial intelligence in education is also the distinction between the concepts of “automation of learning” and “intellectualization of the educational process.” If automation involves performing standard operations without taking into account the individual characteristics of the learner, then intellectualization, inherent in AI systems, is aimed at supporting cognitive activity, developing thinking, and forming the ability to make independent decisions.

In the education of foreign students, artificial intelligence acquires additional importance as a means of linguistic, cognitive and academic adaptation. The ability to explain the material in various ways, the use of simplified formulations, examples and visualizations allows to lower the barriers to the perception of complex technical material without distorting its scientific essence.

Within the framework of this methodological publication, artificial intelligence is considered as a complex multifunctional pedagogical tool that, if used scientifically substantiated, methodically balanced and ethically controlled, contributes to improving the quality of technical education, developing engineering thinking and forming professional competencies of higher education students.

For a clearer understanding of the place of artificial intelligence among modern digital educational tools, it is advisable to conduct a comparative analysis of the main concepts used in the field of digitalization of education (see Table 1.1).

Table 1.1.

Comparative characteristics of digital educational technologies

Comparison criterion	Artificial Intelligence (AI)	Information and Communication Technologies (ICT)	Expert systems
Main purpose	Intellectual support for educational and cognitive activities	Storage, transmission and visualization of information	Providing recommendations based on formalized knowledge
Working principle	Data analysis, learning, adaptation and decision generation	Execution of predefined algorithms	Logical inference based on knowledge base and rules
Level of adaptability	High, taking into account the individual characteristics of the education seeker	Absent or minimal	Limited by the framework of established rules
Nature of interaction	Dialog, interactive, multimodal	Mostly one-sided	Request–response
Learning ability	Yes (machine learning, analysis of results)	Missing	None or minimal
Role in technical education	Explaining complex concepts, supporting engineering solutions	Material submission tool	Consulting support in specific industries
Methodological status	Innovative pedagogical tool	Basic digital learning infrastructure	Specialized tool

The presented comparative analysis allows us to conclude that artificial intelligence is a qualitatively new stage in the development of digital educational technologies, which combines the capabilities of traditional ICT and expert systems, while significantly expanding them due to adaptability, dialogicity, and orientation towards supporting engineering thinking.

In scientific and methodological sources on the subject of artificial intelligence, it is common to divide AI into so-called “weak” (narrow) and “strong” (general) artificial intelligence. Such a distinction is of fundamental importance for the correct use of the term “artificial intelligence” in the educational process.

Weak (narrow) artificial intelligence is a system designed to solve specific, well-defined tasks within a given subject area. They do not have consciousness or universal thinking, and their «intelligence» is realized through algorithms for data analysis, learning from examples and generating answers within given limits. It is to this category that modern educational AI tools used to explain educational material, support problem solving, analyze errors and advise students belong.

Strong (general) artificial intelligence is considered as a hypothetical type of intelligent systems capable of universal thinking, independent goal formation, awareness of one’s own activities, and knowledge transfer between different subject areas. At the current stage of development of science and technology, strong AI has not been implemented in practice and remains the subject of theoretical research and philosophical discussions.

For the methodology of teaching technical disciplines in higher education institutions, in particular at the Admiral Makarov National Shipbuilding University, it is fundamentally important to realize that the use of AI in the educational process is limited to the use of weak artificial intelligence systems. This approach allows you to avoid inflated expectations, methodological errors, and improperly placing responsibility for learning outcomes on digital tools.

Distinguishing between the concepts of «weak» and «strong» artificial intelligence helps teachers and students develop a realistic, scientifically based understanding of the possibilities and limitations of modern AI technologies in technical education.

In order to clarify and unify the conceptual apparatus used when considering the application of artificial intelligence in teaching electrical engineering and automation disciplines, it is advisable to systematize the main terms and their interpretation. This is especially important in the process of teaching foreign students, for whom the correct understanding of professional terminology directly affects the quality of assimilation of educational material.

The table below. 1.2 reflects **the key concepts of artificial intelligence,** adapted to the specifics of training specialists in specialties **G3 «Electrical Engineering»** and **G7 «Automation, Computer-Integrated Technologies and Robotics»,** and also illustrates possible examples of their use in the educational process. The use of such conceptual systematization contributes to the formation of a holistic understanding of the possibilities and limitations of modern AI technologies in technical education among students and ensures methodological consistency of further presentation of the material (see table 1.2).

Table 1.2

Basic concepts of artificial intelligence that are used in the educational process when training specialists in specialties G3 and G7

Concept	Definition (adapted to electrical engineering and automation)	Example of use in the educational process
1. Artificial Intelligence (AI)	A set of methods and algorithms that provide intelligent support for the analysis, modeling, and control of electrical and automated systems	Explanation of the principles of operation of an AC electric drive with analysis of characteristics
2. Educational artificial intelligence	Applied use of AI to support teaching technical disciplines, solving engineering problems, and developing professional competencies	Assistance to the student in calculating electrical circuits or synthesizing a control system
3. Weak (narrow) AI	AI systems focused on solving specific technical problems within a specific subject area	Consultation on setting up a PI controller in an automatic control system
4. Strong (general) AI	A hypothetical universal intelligence capable of independent engineering thinking and design	Not used in the educational process; considered only theoretically
5. Machine learning	AI methods that provide analysis of experimental and model data of electrical systems	Analysis of current and voltage waveforms to identify operating modes.
6. Neural networks	Mathematical models for approximating nonlinear characteristics of electrical and mechatronic systems	Modeling the nonlinear characteristics of an electric machine
7. Natural Language Processing (NLP)	AI technologies for analyzing and generating technical texts, instructions, and explanations.	Explanation of English documentation for PLC or frequency converter
8. Adaptive learning	Organization of training taking into account the level of knowledge of the student in electrical engineering and automation	Gradual complication of problems in the theory of automatic control
9. Intelligent educational assistant	AI tool for consulting, explaining, and checking the logic of engineering solutions	Verification of the robotic manipulator control algorithm
10. Intellectualization of the educational process	Transition from formal calculation to analysis and engineering interpretation of results.	Analysis of the influence of control system parameters on its stability
11. Information and Communication Technologies (ICT)	Digital tools for presenting and sharing educational information without intellectual adaptation	Using electronic textbooks and presentations
12. Expert system	A system with formalized rules for making decisions in a narrow technical field	Selecting the type of electric motor based on given parameters
13. Automatic control system (ACS)	An engineering object for the analysis and synthesis of which AI tools can be used	Optimization of speed controller parameters
14. Modeling of electrical systems	The process of creating mathematical and computer models of electrical and automated objects	Building an electric drive model in an educational environment

The given conceptual table allows to systematize the main terms related to the application of artificial intelligence in electromechanics and automation, as well as to clearly distinguish their functional and methodological purpose. Such structuring contributes to the awareness of the role of artificial intelligence as a tool for intellectual support of the educational process, and not as an autonomous source of engineering solutions.

Adaptation of key concepts to the specifics of disciplines of specialties G3 and G7 ensures their correct use in teaching electrical engineering, automatic control theory, robotics and related engineering courses. The use of a consistent conceptual apparatus creates a methodological basis for further consideration of the classification and practical aspects of the application of artificial intelligence systems in the educational process of the Admiral Makarov National University of Shipbuilding.

1.2. CLASSIFICATION OF ARTIFICIAL INTELLIGENCE SYSTEMS USED IN THE EDUCATIONAL PROCESS

In the modern educational process of higher technical education institutions, artificial intelligence systems are represented by various software tools that differ in functional purpose, level of intellectualization and scope of application. For methodically justified use of AI in obtaining education by foreign higher education applicants, their systematic consideration is advisable.

Classification of AI systems by functional purpose. According to their functional purpose, artificial intelligence systems used in the educational process can be divided into the following main groups:

– information and analytical systems designed to search, process and generalize educational and scientific and technical information;

– explanatory and advisory systems that provide interpretation of complex technical concepts, algorithms and models;

– diagnostic systems used to analyze the level of development of educational and professional competencies of education seekers;

– project-oriented systems that support the implementation of coursework, project work, and qualification work.

For specialties G3 and G7, the greatest practical value is given to explanatory and project-oriented systems capable of working with mathematical models, electrical circuits, and automatic control algorithms (see Table 1.3).

Table 1.3 shows the division of artificial intelligence systems according to their functional role in the educational process. The proposed classification allows you to correlate the capabilities of AI with specific types of educational activities and determine the appropriateness of their use for the formation of educational and professional competencies of higher education students.

Of particular methodological value for the training of electrical and automation specialists are explanatory, consulting, and project-oriented systems that provide interpretation of complex engineering models and support for technical decision-making.

Table 1.3

Classification of artificial intelligence systems by functional purpose

Type of AI systems	Characteristic	Application example in electrical engineering and automation
Information and analytical	Provide search, generalization and analysis of educational and scientific and technical information	Analysis of electrical machine characteristics, review of control methods
Explanatory	Provide interpretation of complex technical concepts and models	Explanation of the principles of operation of an induction motor
Consulting	Provide recommendations when solving engineering problems	Consultation on the selection of PI controller parameters
Diagnostic	Analyze the results of educational activities of students	Identifying common errors in electrical circuit calculations
Project-oriented	Support the completion of coursework and qualification work	Analysis of automatic control system options

Application examples:

- *Information and analytical systems of artificial intelligence can be used to process scientific and technical sources, standards and technical documentation in electrical engineering and automation. For example, when studying electrical machines, such systems are used to generalize the parameters and characteristics of different types of engines;*
- *explanatory AI systems are appropriate for interpreting complex physical and mathematical models, in particular when explaining transient processes in electrical circuits or the principles of operation of automatic control systems;*
- *Consulting systems are used when performing practical tasks, for example, when selecting controller parameters or analyzing the stability of a control system. Project-oriented systems are used when performing coursework and qualification work to analyze alternative engineering solutions.*

Classification of AI systems by level of adaptability. Depending on the ability of systems to take into account the individual characteristics of education seekers, artificial intelligence systems are divided into:

– non-adaptive, which provide the same information regardless of the user's level of training;

– partially adaptive, which adjust the complexity or form of presentation of the material based on a limited set of parameters;

– adaptive, capable of analyzing learning actions, errors, and the pace of learning in order to personalize the educational trajectory.

The use of adaptive AI systems is particularly appropriate in the acquisition of education by foreign higher education applicants, as it allows taking into account the linguistic and cognitive characteristics of the contingent (see Table 1.4).

Table 1. 4

Classification of artificial intelligence systems by level of adaptability

Level of adaptability	Description	Methodological significance
Maladaptive	Provide the same information to all education seekers	Limited application
Partially adaptive	Adjust the complexity or form of presentation of the material	Expedient in the initial stages
Adaptive	They take into account the level of preparation, pace and mistakes.	Optimal for foreign education seekers

Table 1.4 systematizes artificial intelligence systems by their ability to adapt to the individual characteristics of students. This approach is especially important in the context of education for foreign students of higher education, who are characterized by differences in basic training, language competence and the pace of learning.

Adaptive AI systems create conditions for personalizing the educational trajectory and increasing the efficiency of the formation of professional competencies, while non-adaptive systems have limited methodological application.

Application examples:

- *non-adaptive artificial intelligence systems can be used to provide reference information or typical explanations regardless of the level of training of the student. Their use is advisable at the stage of initial familiarization with the topic;*
- *Partially adaptive systems can adjust the complexity of tasks or the form of presentation of material depending on the results of previous tasks. For example, when studying the theory of automatic control, such systems offer different levels of complexity of tasks;*
- *Adaptive AI systems are most effective for foreign higher education students, as they allow them to take into account language features and the individual pace of education, in particular when explaining control algorithms or mathematical models.*

Classification of AI systems by subject focus. By subject focus, artificial intelligence systems in the educational process are divided into:

– universal, which can be applied to different fields of knowledge;
– industry-specific, focused on specific engineering areas;
– Highly specialized, designed to solve individual technical problems.

Within the educational programs «Electrical Engineering and Electrical Technologies» and «Automation and Robotics», it is advisable to use industry-specific and highly specialized systems that provide work with electrical circuits, automatic control systems, electric drives, and robotic complexes (see Table 1.5).

Table 1.5 shows the distribution of artificial intelligence systems depending on their subject orientation. This classification allows for an informed choice of AI tools in accordance with the content of educational programs and the specifics of the disciplines of electrical engineering and automation cycles.

Table 1.5

Classification of artificial intelligence systems by subject area

Type of systems	Scope of application	Examples of disciplines
Universal	General engineering training	Higher mathematics, physics
Industry	Specific engineering areas	Theory of electrical circuits, YES
Highly specialized	Certain technical tasks	PLC, robotics, electric drive

The use of industry-specific and highly specialized AI systems contributes to the formation of practically oriented engineering thinking among students and ensures a close connection between theoretical knowledge and real technical tasks.

Application examples:

- *universal artificial intelligence systems can be used to support general engineering training, for example, when studying the mathematical apparatus or the physical foundations of electrical engineering;*
- *industry systems are focused directly on electrical engineering and automation and are used to analyze electrical circuits, electric drive systems, or automated technological processes;*
- *Highly specialized AI systems are used to solve individual technical problems, in particular when programming programmable logic controllers, modeling robotic systems, or optimizing the parameters of electric drives.*

Classification of AI systems by stages of the educational process. Taking into account the stages of the educational process, artificial intelligence systems can be used for:

– support for the assimilation of theoretical material;
– support for practical and laboratory classes;
– organization of independent work of education seekers;
– implementation of project and research tasks.

This approach allows integrating AI into the educational process as an auxiliary tool that contributes to the formation of engineering thinking and the development of professional competencies (see Table 1.6).

Table 1.6

Classification of AI systems by stages of the educational process

Stage of the educational process	Purpose of using AI	Expected result
Learning the theory	Explanation of concepts and models	Understanding the physical nature of processes
Practical classes	Support for calculations	Formation of professional competencies
Independent work	Self-check and analysis	Developing independence
Project activities	Analysis and justification of decisions	Engineering thinking

Table 1.6 presents a systematization of artificial intelligence systems according to the stages of the educational process. This approach allows integrating AI as an auxiliary tool at all stages of education – from the processing of theoretical material to the implementation of project and research tasks.

The proposed classification contributes to the gradual formation of educational and professional competencies and ensures methodological consistency in the use of AI within educational programs in G3 and G7 specialties.

Application examples:

- *at the stage of mastering theoretical material, artificial intelligence systems are used to explain basic concepts and the physical essence of processes, for example, in the theory of electrical circuits or the theory of automatic control;*
- *during practical and laboratory classes, AI is used to support calculations, analyze modeling results, and verify the correctness of control algorithms;*
- *in the process of independent work of education seekers, AI systems can serve as a means of self-checking and error analysis. At the design and research stage, AI is used to analyze alternative technical solutions and justify the selected options.*

In order to generalize and systematize approaches to the classification of artificial intelligence systems used in the educational process of technical education, it is advisable to present an integrated classification that combines the main features of the division of AI tools by functional purpose, level of adaptability, subject focus, and stages of the educational process.

The generalized classification presented in Table 1.7 reflects the methodological logic of choosing and using artificial intelligence systems in accordance with the goals of educational programs, the features of obtaining education by foreign higher education students, and the requirements for the formation of educational and professional competencies in the specialties G3 «Electrical Engineering» and G7 «Automation, Computer-Integrated Technologies and Robotics».

The summary table. 1.7 allows for a comprehensive presentation of artificial intelligence systems from the standpoint of their pedagogical and methodological application in the educational process. Such structuring simplifies the selection of AI tools in accordance with the goals of educational programs, stages of education and expected results of the formation of educational and professional competencies of higher education applicants in specialties G3 and G7.

The generalized classification allows combining different features when choosing AI tools. For example, for project activities of foreign students, it is advisable to use adaptive, industry-specific, project-oriented systems, while for mastering theoretical foundations, it is sufficient to use explanatory or information-analytical systems.

The proposed classification of artificial intelligence systems creates a methodological basis for their purposeful and pedagogically appropriate use in the educational process of the Admiral Makarov National Shipbuilding University. A systematized approach to the selection of AI tools allows ensuring compliance between the goals of educational programs, the level of training of education

Table 1.7

Generalized classification of artificial intelligence systems in the educational process in technical specialties

Classification sign	Type of AI systems	Methodological purpose in the educational process
Functional purpose	information and analytical	Search, generalization and analysis of educational and scientific and technical information
	explanatory	Interpreting complex technical concepts and models
	consulting	Support for solving engineering problems
	diagnostic	Analysis of the level of formation of educational and professional competencies
	project-oriented	Support for project and research activities
Level of adaptability	maladaptive	Standardized presentation of educational material
	partially adaptive	Partial personalization of the educational trajectory
	adaptive	Individualization of education
Subject focus	universal	Support for general engineering training
	industry	Orientation to electrical engineering and automation
	highly specialized	Solving specific technical problems
Stage of the educational process	theoretical	Mastering fundamental concepts
	practical	Formation of professional competencies
	independent work	Developing independence and responsibility
	project-research	Development of engineering thinking

seekers, and the expected results of the formation of educational and professional competencies.

The presentation of the classification of artificial intelligence systems in the form of tables provides a structured and clearly understandable presentation of their capabilities and methodological purpose in the educational process. This approach contributes to the conscious choice of AI tools in accordance with the goals of educational programs, the level of training of foreign higher education applicants, and the requirements for the formation of educational and professional competencies in G3 and G7 specialties.

1.3. METHODOLOGICAL APPROACHES TO THE USE OF ARTIFICIAL INTELLIGENCE IN THE EDUCATIONAL PROCESS OF TECHNICAL EDUCATION

The use of artificial intelligence systems in the educational process of higher technical education institutions requires a scientifically sound methodological

approach that ensures their pedagogical feasibility and compliance with the goals of educational programs. For the training of specialists in the field of electromechanics and automation, it is advisable to combine a number of complementary methodological approaches that determine the principles of integrating AI into educational activities.

System approach. The system approach involves considering the educational process as a holistic set of interconnected components: educational goals, content of academic disciplines, methods and forms of organizing educational activities, teaching aids and educational outcomes. Within this approach, artificial intelligence systems are considered as an element of the educational environment that interacts with its other components.

The use of AI from the standpoint of a systems approach ensures consistency between the use of digital tools and the expected results of the formation of educational and professional competencies of higher education applicants in specialties G3 and G7 (see Table 18).

Table 1.8 illustrates the possibilities of implementing a systemic approach to the use of artificial intelligence in the educational process of technical education. The components of the educational process presented in the table reflect the relationship between the goals of educational programs, the content of disciplines, forms of educational activity and the results of obtaining education.

The use of AI within a systemic approach allows for consistency between the use of digital tools and the expected results of the formation of educational and professional competencies of higher education students, and also contributes to the integrity of the educational process.

Table 1.8

Implementing a systems approach using AI

Component of the educational process	The role of AI	Methodological result
Educational program goals	Aligning AI tools with learning outcomes	Competency compliance
Content of disciplines	Structuring the learning material	Logical sequence of topics
Forms of educational activity	Support for lectures, practicals, projects	Integrity of the educational process
Educational outcomes	Analysis of achieved results	Control of the formation of competencies

Application examples:

- *in electrical engineering disciplines, AI can be used to reconcile theoretical material with practical tasks, for example, when combining the study of electrical circuit theory with the modeling of real circuits. In automation systems, AI allows for a logical connection between the study of control theory and the implementation of algorithms in programmable logic controllers.*

Competency-based approach. The competency-based approach is basic for modern higher education and orients the educational process towards the formation of integrated educational and professional competencies. The use of artificial intelligence in this context is considered as a means of supporting the development of analytical thinking, the ability to solve engineering problems and make technical decisions.

AI tools contribute to the formation of such competencies as the ability to analyze technical data, work with mathematical models, interpret modeling results, and justify engineering decisions (see Table 1.9).

Table 1.9 shows the role of artificial intelligence in the formation of educational, professional, digital and analytical competencies of higher education students. Such systematization allows us to consider AI not as a universal means of learning, but as a tool for targeted support of individual components of the graduate's competency model.

Table 1.9

Using AI within a competency-based approach

Type of competence	AI-powered support	Expected result
Educational	Explanation of theoretical foundations	Deep understanding of processes
Professional	Analysis of technical tasks	Ability to make engineering decisions
Digital	Working with digital models	Engineering digital literacy
Analytical	Interpretation of results	Reasoned conclusions

The methodological value of Table 1.9 lies in the possibility of correlating AI functions with the results of educational attainment defined by educational programs in specialties G3 and G7.

Application examples:

- *During education in the G7 specialty, AI can be used to analyze the stability of automatic control systems, which contributes to the formation of professional competencies in the field of automation.*
- *For G3, AI is appropriate for analyzing the energy modes of electric drives and selecting optimal system parameters.*

Activity-based approach. The activity-based approach focuses on the active cognitive and practical activities of learners. Within this approach, artificial intelligence systems are used to support the implementation of practical, laboratory, and project tasks that require the active application of knowledge.

The use of AI promotes the transition from reproductive assimilation of material to the active formation of professional competencies, which is especially important in the training of engineers (see Table 1.10).

Table 1.10 demonstrates the possibilities of using artificial intelligence systems to support active cognitive and practical activities of education seekers.

Table 1.10

Implementing an activity-based approach using AI

Type of activity	AI function	Methodical effect
Practical classes	Support for calculations	Activation of cognitive activity
Laboratory work	Analysis of results	Understanding cause and effect relationships
Project tasks	Analysis of alternatives	Development of engineering thinking

It reflects the relationship between types of educational activities, AI functions and expected methodological effects.

The use of AI within the framework of an activity-based approach contributes to the transition from reproductive assimilation of material to the formation of the ability to apply knowledge in practical and design engineering tasks.

Application examples:

- *in the process of performing laboratory work on automation, AI can be used to analyze the behavior of the system when changing the controller parameters;*
- *in electrical engineering disciplines – to explain the differences between theoretical calculations and modeling results.*

Person-centered approach. A person-centered approach involves taking into account the individual educational needs, level of preparation and cognitive characteristics of education seekers. For foreign higher education seekers, this is of particular importance given the linguistic and cultural differences.

Artificial intelligence systems, in particular adaptive and explanatory ones, create conditions for individualizing educational trajectories and increasing the efficiency of education without simplifying the engineering content of disciplines (see Table 1.11).

Table 1.11 reflects the possibilities of using artificial intelligence taking into account the individual educational characteristics of higher education applicants. Such a classification is of particular methodological significance in the context of obtaining education by foreign higher education applicants, for whom language adaptation, the pace of learning, and the level of basic training are important.

The use of AI within a person-centered approach allows for the individualization of educational trajectories without reducing the requirements for engineering training.

Table 1.11

Person-centered use of AI

Educational characteristics of the applicant	AI function	Educational outcome
Basic training level	Adapting complexity	Individual trajectory
Language competence	Alternative explanations	Better assimilation of the material
Pace of education	Load personalization	Increasing motivation

Application examples:

- *For international students, AI can provide explanations of technical concepts in simplified language or with the use of visualizations. This allows you to preserve the engineering complexity of the material while increasing its accessibility.*

The activity-based approach ensures the active involvement of higher education students in solving practical and project tasks, and the personally oriented approach creates conditions for the individualization of educational trajectories, which is especially important in the context of obtaining education by foreign higher education students.

Thus, the use of artificial intelligence based on certain methodological approaches forms a scientifically sound basis for further consideration of practical aspects of its implementation in the educational process of technical education and ensures an improvement in the quality of formation of educational and professional competencies of higher education students.

1.4. CURRENT TRENDS IN THE DIGITALIZATION OF TECHNICAL EDUCATION

Digitalization of technical education is one of the key areas of development of the higher education system and is determined by the needs of modern industry, energy and automated production. In the context of digital transformation of engineering activities, the educational process is focused on developing the ability of higher education students to work with digital models, information systems and intelligent technologies.

The main current trends in the digitalization of technical education include: the integration of digital learning environments, the use of computer modeling and virtual laboratories, the development of distance and blended forms of education, as well as the introduction of educational data analysis systems. In this context, artificial intelligence is considered the next stage of the development of digital technologies, which ensures the transition from the automation of the educational process to its intellectualization.

For the training of specialists in the electrical engineering and automation field, the digitalization of education creates conditions for a closer connection between theoretical training and practical engineering tasks, which meets modern requirements for the professional activity of an engineer (see Table 1.12).

Table 1.11 reflects the key areas of digital transformation of technical education in the context of modern development of engineering activities. The presented trends characterize the transition from the use of individual digital tools to the formation of a holistic digital educational environment, within which the integration of educational resources, modeling of engineering systems and analysis of educational activity results are ensured.

Table 1.12

Main trends in the digitalization of technical education

Trend	Content	Importance for technical education
Digital educational environments	Integration of LMS, electronic resources	Unified educational space
Computer modeling	Using digital models	The connection between theory and practice
Remote and mixed forms	Flexible education formats	Accessibility for foreigners
Educational data analysis	Collection and analysis of learning outcomes	Improving the quality of education
Intellectualization	Using AI	Personalization of education

Application examples:

- *in the disciplines of the electrical engineering cycle, digitalization is implemented through the use of software tools for modeling electrical circuits and electric drives;*
- *in automation – through digital design of control systems and modeling of robotic complexes. Artificial intelligence in this context acts as a tool for analyzing modeling results and explaining the differences between theoretical and practical operating modes of systems.*

The identification of the intellectualization of the educational process as a separate trend emphasizes the role of artificial intelligence as a tool that provides a qualitatively new level of digitalization, focused on the personalization of education and the formation of modern educational and professional competencies.

1.5. DIDACTIC POSSIBILITIES OF ARTIFICIAL INTELLIGENCE IN HIGHER TECHNICAL EDUCATION

Artificial intelligence has significant didactic potential in higher education institutions, as it allows expanding traditional teaching methods and providing new forms of organizing the educational process. The main didactic feature of AI is the ability to adaptively interact with students and support individualized educational trajectories.

The main didactic capabilities of artificial intelligence include: explaining complex technical concepts using alternative formulations and examples, supporting independent educational activities, providing immediate feedback on the results of task performance, and promoting the development of analytical and systems thinking.

In technical education, AI allows us to shift the emphasis from mechanical reproduction of information to understanding the physical essence of processes,

analyzing engineering solutions, and developing the ability to make informed technical decisions, which is directly related to the formation of professional competencies (see Table 1.13).

Table 1.13

Didactic possibilities of AI in technical education

Didactic function	Implementation using AI	Educational outcome
Explanatory	Alternative explanations	Deep understanding
Adaptive	Content personalization	Individual trajectories
Control	Error analysis	Formation of competencies
Consulting	Support for independent work	Developing autonomy
Analytical	Interpretation of results	Engineering thinking

Application examples:

- *When studying the theory of automatic control, AI can explain step-by-step the influence of controller parameters on the stability of the system. In electrical engineering, it can help students interpret the results of calculations and modeling, explaining the physical nature of the obtained characteristics.*

Table 1.13 systematizes the main didactic functions of artificial intelligence, taking into account the sectoral orientation of the higher education institution. The presented structure allows us to consider AI as a multifunctional pedagogical tool that complements traditional teaching methods and expands the possibilities of organizing the educational process.

The methodological value of the table lies in establishing a direct connection between the didactic functions of AI and the expected results of the formation of educational and professional competencies of higher education students. This approach contributes to the conscious and purposeful use of AI in educational activities.

1.6. PSYCHOLOGICAL AND PEDAGOGICAL ASPECTS OF TEACHING FOREIGN STUDENTS

The education of foreign higher education students in technical education institutions is characterized by a number of psychological and pedagogical features related to language barriers, different levels of previous training, and differences in educational traditions. In these conditions, the creation of a supportive educational environment focused on the gradual adaptation of education students to the requirements of engineering training becomes particularly relevant.

Artificial intelligence in this context can serve as a tool for psychological and pedagogical support, providing a step-by-step explanation of educational

material, adapting terminology, and reducing cognitive load. At the same time, it is important that the use of AI does not replace the active cognitive activity of students, but contributes to the development of their independence and responsibility for the results of their education.

The use of AI, taking into account psychological and pedagogical aspects, allows to increase the motivation of foreign higher education applicants, create conditions for the formation of a positive educational experience, and ensure the effective formation of educational and professional competencies (see Table 1.14).

Table 1.14

Psychological and pedagogical factors of teaching foreign students

Factor	Manifestation in the educational process	The role of AI
Language barrier	Complexity of technical terminology	Adaptation of explanations
Training level	Uneven basic knowledge	Differentiation of tasks
Cognitive features	Different thinking styles	Alternative formats
Motivation	Adaptation stress	Support and feedback
Independence	Difficulties of self-study	Consulting support

Application examples:

- *For international students, AI can be used as a tool for pre-explaining complex topics before classroom lessons. For example, before studying electric drive systems, AI helps to master basic terminology and operating principles, which reduces cognitive load during the main lesson.*

Table 1.13 reflects the main psychological and pedagogical factors that influence the effectiveness of education for foreign higher education students in technical institutions. It systematizes typical adaptation difficulties and identifies the role of artificial intelligence in creating a supportive educational environment.

The use of AI, taking into account the above factors, allows to reduce cognitive and linguistic load, increase motivation for learning and ensure individualization of educational trajectories without reducing the requirements for engineering training. This approach is methodologically justified in the context of implementing educational programs in G3 and G7 specialties.

SECTION 2. FEATURES OF TEACHING TECHNICAL DISCIPLINES FOR G3 AND G7 SPECIALTIES

Teaching technical disciplines in specialties **G3 "Electrical Engineering"** and **G7 "Automation, Computer-Integrated Technologies and Robotics"** has a number of specific features due to the content of educational programs, requirements for the formation of professional competencies, and the nature of the future professional activities of higher education applicants.

For the G3 specialty, the priority is to develop in students the ability to analyze electrical and electromechanical processes, work with electrical circuits, operating modes of electrical machines and electric drive systems. The educational process is focused on a deep understanding of the physical essence of processes, mathematical modeling and engineering interpretation of calculation results.

For the G7 specialty, the emphasis is shifted to the formation of competencies in the field of automatic control, programming of technical systems, analysis and synthesis of control algorithms, as well as the integration of hardware and software components of automated and robotic complexes. An important feature is the interdisciplinary nature of the training, combining electrical engineering, computer science, control theory and mechatronics.

A common feature of teaching technical disciplines for specialties G3 and G7 is a high level of abstraction of educational material, a significant proportion of mathematical apparatus and the need to form systemic engineering thinking. This requires a combination of theoretical training with practical and laboratory classes, the use of modeling and a gradual complication of tasks.

In the context of education of foreign higher education students, these features are complemented by linguistic and cognitive factors, which necessitates a clear structuring of educational material, unification of terminology, and the use of visual and explanatory tools. The use of artificial intelligence tools in this case is considered as an auxiliary means of supporting educational activities, which contributes to better mastering of complex technical concepts without reducing the requirements for the level of engineering training.

Thus, the features of teaching technical disciplines for specialties G3 and G7 are determined by a combination of industry specifics, interdisciplinarity, and the need to form modern engineering competencies, which requires a methodically balanced use of modern digital and intellectual technologies in the educational process.

2.1. COMPETENCY-BASED APPROACH IN THE TRAINING OF ELECTRICAL ENGINEERING SPECIALISTS (G3)

The training of electrical engineering specialists in the specialty G3 in higher technical education institutions is based on a competency-based approach,

which involves focusing the educational process on the formation of integrated educational and professional competencies necessary for the implementation of professional engineering activities. Within the framework of this approach, the results of obtaining education are determined not only by the amount of acquired knowledge, but primarily by the ability of higher education graduates to apply them for the analysis, design and operation of electrical engineering systems.

For the G3 specialty, the key competencies are those related to the analysis of electrical and electromagnetic processes, calculation and modeling of electrical circuits, selection and operation of electrical machines and electric drive systems, as well as interpretation of the results of engineering calculations. The implementation of the competency approach requires a combination of theoretical training with practically oriented types of educational activities (see Tables 2.1 and 2.2).

Table 2.1 reflects the relationship between the key professional competencies of higher education applicants in the G3 specialty and the main forms of organizing the educational process. Such structuring allows for targeted formation of competencies by combining theoretical training with practical and project activities, which is crucial for the training of electrical engineers.

Table 2.2 reflects the functional role of artificial intelligence tools in implementing the competency-based approach in the training of electrical engineering specialists in the specialty G3. It systematizes the main types of educational activities and the corresponding AI functions that contribute to the formation of educational and professional competencies of higher education applicants.

The relationship between educational activities, AI functions and expected competence results presented in Table 2.2 allows us to consider artificial intelligence as an auxiliary tool to support the educational process. This approach ensures increased efficiency in learning material, development of analytical and engineering thinking, as well as the formation of the ability to engage in independent educational activities without replacing the engineering responsibility of education seekers.

Table 2.1

Formation of professional competencies of higher education applicants in the G3 specialty in the educational process

Professional competence	Competency content	Main forms of educational activity
Analysis of electrical processes	Understanding the physical nature of electrical and electromagnetic phenomena	Lectures, tutorials
Modeling electrical circuits	Building mathematical and computer models	Practical and laboratory work
Working with electrical machines	Analysis of operating modes and characteristics	Laboratory classes
Engineering interpretation of results	Evaluation and explanation of calculation results	Project tasks
Making technical decisions	Reasoned choice of parameters and solutions	Course and qualification papers

Table 2.2

The role of artificial intelligence tools in implementing the competency approach (G3)

Educational activities	AI function	Competency result
Theory development	Explanation of complex concepts	Deep understanding of processes
Calculation work	Error analysis	Formation of engineering logic
Modeling	Interpretation of results	Analytical competencies
Independent work	Consulting support	Educational autonomy
Project activities	Analysis of alternatives	Engineering thinking

Examples of implementing a competency-based approach (G3):

- *Example 1. When studying the theory of electrical circuits, artificial intelligence tools can be used to explain step-by-step processes in alternating current circuits with an emphasis on the physical essence of phenomena, which contributes to the formation of analytical competencies.*
- *Example 2. In the process of performing laboratory work on electrical machines, AI can help students interpret the obtained characteristics and explain the differences between theoretical and experimental results.*
- *Example 3. During the course design of electric drive systems, AI can be used to analyze alternative technical solutions, while the responsibility for choosing the final solution remains with the higher education student.*

The implementation of a competency-based approach in the training of electrical engineering specialists in the G3 specialty ensures the orientation of the educational process towards the formation of the ability of higher education applicants to apply the results of their studies for the analysis, modeling and solution of practical engineering problems. This approach meets the requirements of higher education standards and modern demands of engineering practice.

Methodically balanced use of artificial intelligence tools contributes to increasing the effectiveness of the formation of educational and professional competencies, in particular the ability to analyze electrical engineering processes, interpret the results of calculations and modeling, and make sound technical decisions. At the same time, artificial intelligence is considered as an auxiliary tool to support educational activities, and not as a replacement for independent engineering work of education seekers.

The competency-based approach is of particular importance in the context of education for foreign higher education students, since the combination of complex engineering content with linguistic and cognitive challenges requires a clear structuring of educational material and the gradual formation of educational and professional competencies. The use of artificial intelligence tools creates conditions for individualizing educational trajectories and increasing the effectiveness of the educational process without reducing the requirements for the level of engineering training.

2.2. SPECIFICS OF TRAINING SPECIALISTS IN AUTOMATION AND ROBOTICS (G7)

Training of specialists in the specialty **G7 "Automation, computer-integrated technologies and robotics"** has a pronounced interdisciplinary nature and is aimed at the formation of educational and professional competencies related to the design, analysis and operation of automated and robotic systems. The educational process within this specialty combines knowledge of electrical engineering, automatic control theory, programming, digital electronics and mechatronics.

The specifics of G7 specialist training are orientation towards a systems vision of technical objects, integration of hardware and software components, and the ability to work with real-time control algorithms. An important role is played by the formation of competencies in the field of dynamic systems analysis, regulator synthesis, programmable logic controllers and robotic platforms.

In order to specify the content of professional training for automation and robotics specialists, it is advisable to systematize key professional competencies, the formation of which is provided within the educational programs of the G7 specialty. Generalization of such competencies in tabular form allows you to correlate the requirements of higher education standards with the main forms of organization of the educational process and types of educational activities (see Table 2.3).

Table 2.3 reflects the main professional competencies, the formation of which is a priority in the training of automation and robotics specialists. The combination of theoretical training with practical and project-based educational activities ensures the formation of systems engineering thinking and readiness for professional activity in the field of automated systems.

Given the interdisciplinary nature of training specialists in the G7 specialty and the high level of complexity of the educational material, it is relevant to determine the role of artificial intelligence tools in the implementation of the educational process. For this purpose, it is advisable to consider the possibilities of using AI in various types of educational activities and their impact on the

Table 2.3

Key professional competencies of higher education applicants in the G7 specialty

Professional competence	Competency content	Main forms of educational activity
Control systems analysis	Understanding system dynamics and stability	Lectures, practical classes
Synthesis of regulators	PI/PID controller settings	Practical and laboratory work
Programming of technical systems	Development of control algorithms	Laboratory work
Hardware and software integration	Building automated systems	Project activities
Robotic systems analysis	Kinematics and motion control	Course projects

formation of educational and professional competencies of higher education applicants, which is presented in Table 2.4.

Table 2.4

Using artificial intelligence tools in training G7 specialists

Type of educational activity	AI function	Competency result
Mastering control theory	Explanation of mathematical models	Understanding system dynamics
Practical classes	Analysis of calculation errors	Engineering logic
Laboratory work	Interpretation of results	Analytical competencies
Independent work	Consulting support	Educational autonomy
Project activities	Analysis of alternative solutions	Systems thinking

Table 2.4 reflects the directions and functional capabilities of using artificial intelligence tools in the educational process of training specialists in automation and robotics in the specialty G7. It systematizes the main types of educational activities, AI functions, and expected results of the formation of educational and professional competencies of higher education applicants.

The relationship presented in the table allows us to consider artificial intelligence as an auxiliary tool for supporting educational activities, which contributes to a deeper understanding of dynamic systems, control algorithms, and the principles of integration of hardware and software components of automated and robotic complexes. This approach ensures a methodically balanced use of AI without replacing the independent engineering activities of education seekers.

Examples of implementation of training specifics (G7):

- *Example 1. In disciplines on the theory of automatic control, artificial intelligence tools can be used to explain step-by-step the influence of controller parameters on the stability and quality of transient processes.*
- *Example 2. During laboratory work on programming programmable logic controllers, AI can help students analyze the logic of control algorithms and identify typical errors.*
- *Example 3. Within the framework of the course design of robotic systems, AI can be used to analyze kinematic schemes and possible variants of control algorithms, without replacing independent engineering decision-making.*

The specificity of training specialists in automation and robotics (G7) is interdisciplinary, focused on system analysis and synthesis of technical systems, as well as the integration of hardware and software components. The use of artificial intelligence tools in the educational process is considered as an auxiliary means of supporting the formation of professional competencies, the development of engineering and systems thinking of higher education students.

2.3. TYPICAL DIFFICULTIES IN MASTERING TECHNICAL DISCIPLINES BY FOREIGN STUDENTS

The acquisition of higher education by foreign applicants in technical specialties G3 and G7 is accompanied by a number of objective difficulties that affect the effectiveness of the educational process and the formation of educational and professional competencies. These difficulties are due to a combination of linguistic, cognitive, educational-cultural and methodological factors that must be taken into account when organizing the teaching of technical disciplines.

It is worth noting that technical disciplines are characterized by a high level of abstraction, a significant amount of specialized terminology, mathematical apparatus, and the need for systematic engineering thinking. For foreign students, these factors can lead to increased cognitive load and a decrease in the rate of assimilation of educational material.

In order to identify and systematize the main factors that complicate the mastery of technical disciplines by foreign students, it is advisable to generalize typical difficulties that arise in the process of obtaining education. The presentation of such difficulties in tabular form allows us to classify them by the nature of their manifestation and assess the impact on the educational process (see Table 2.5).

Table 2.5 systematizes typical difficulties that foreign higher education students face when mastering technical disciplines. The identification of groups of difficulties allows teachers to make a targeted selection of methods and means of organizing the educational process, taking into account the individual and group characteristics of the contingent of education students.

Given the complex nature of the identified difficulties, it is relevant to analyze the possibilities of using artificial intelligence tools to overcome them. To do this, it is advisable to consider the functions of AI in the context of different types of difficulties and the expected methodological effects of their application, which is summarized in Table 2.6.

Table 2.5

The main difficulties in mastering technical disciplines foreign education seekers

Difficulty group	Nature of manifestation	Impact on the educational process
Languages	Insufficient proficiency in the language of instruction, complexity of technical terminology	Difficulty in understanding theoretical material
Cognitive	Different thinking and learning styles	Slower learning of abstract concepts
Educational and cultural	Differences in preliminary preparation	Uneven level of basic knowledge
Methodical	Inconsistency in teaching pace	Overload of learning material
Psychological	Adaptation stress, decreased motivation	Decreased learning activity

Table 2.6 shows the possibilities of using artificial intelligence tools to reduce the negative impact of typical difficulties that arise in the process of mastering technical disciplines by foreign higher education applicants. It systematizes the correspondence between the types of difficulties, AI functions and the expected methodological effects of their use in the educational process.

Table 2.6

Possibilities of using artificial intelligence to overcome typical difficulties

Type of difficulty	AI functions	Expected methodological effect
Languages	Adaptation of explanations, simplification of wording	Better understanding of the material
Cognitive	Alternative ways of presenting information	Reducing cognitive load
Educational	Differentiation of task complexity	Leveling the training level
Methodical	Personalize your learning pace	Increasing the efficiency of assimilation
Psychological	Consulting support	Increasing motivation

The structure presented in the table allows us to consider artificial intelligence as an auxiliary means of pedagogical support aimed at adapting the educational process to the individual educational needs of students. The use of AI in certain areas contributes to reducing the linguistic and cognitive load, increasing motivation for education, and creating conditions for the effective formation of educational and professional competencies without reducing the requirements for the level of engineering training.

Examples of taking into account typical difficulties in the educational process:

- *Example 1. When studying the theory of electrical circuits, artificial intelligence tools can be used to explain terms and formulas in simplified language with additional visualizations, which makes the material easier for foreign students to understand.*
- *Example 2. In automation-related disciplines, AI can help students step by step analyze control algorithms, explaining the logic of each step and reducing the risk of formal learning of the material.*
- *Example 3. In the process of independent work of foreign education seekers, AI can perform the function of a consulting assistant, providing explanations without evaluation and psychological pressure, which helps to increase the confidence of education seekers.*

Typical difficulties in mastering technical disciplines by foreign students are complex and require systematic consideration in the educational process. Their identification and structured analysis create the prerequisites for a methodically substantiated selection of teaching forms and means.

The use of artificial intelligence tools in this context is considered as an auxiliary means of supporting educational activities, which contributes to reducing the linguistic and cognitive load, increasing motivation and the effectiveness of the formation of educational and professional competencies of foreign higher education applicants.

2.4. THE ROLE OF INTERDISCIPLINARY CONNECTIONS AND ENGINEERING THINKING

The formation of engineering thinking is one of the key tasks of training technical specialists in specialties G3 and G7. Engineering thinking involves the ability of higher education applicants to comprehensively analyze technical objects, establish cause-and-effect relationships between processes, and apply knowledge from various fields to solve practical engineering problems.

Interdisciplinary connections play a decisive role in the formation of engineering thinking, since technical disciplines of the electrical engineering direction, as well as disciplines related to automation and robotics, are closely integrated with mathematics, physics, computer science, automatic control theory and mechatronics. Awareness of these relationships contributes to the transition from fragmentary assimilation of educational material to a holistic systemic vision of engineering problems and methods of their solution.

To specify the role of interdisciplinary connections in the training of technical specialists, it is advisable to summarize the main relationships between the educational disciplines of electrical engineering, disciplines of automation and robotics and related fields of knowledge. Such systematization allows us to clearly demonstrate the importance of interdisciplinary integration for the formation of systemic engineering thinking of higher education students, which is reflected in Table 2.7.

Table 2.7

Interdisciplinary connections in the training of G3 and G7 specialists

Discipline	Related fields of knowledge	Engineering result
Theory of electrical circuits	Mathematics, physics	Analysis of electrical processes
Electric machines	Physics, mechanics	Understanding operating modes
Automatic control theory	Mathematics, computer science	Synthesis of control systems
PLC programming	Computer science, electronics	Implementation of algorithms
Robotics	Mechatronics, automation	Traffic control

Table 2.7 illustrates the nature of interdisciplinary connections that underlie the training of specialists in electrical engineering and automation. It demonstrates that the formation of engineering thinking is possible only if knowledge from related fields is integrated, which provides a deep understanding of the functioning of technical systems.

Given the need for targeted formation of engineering thinking in the educational process, it is relevant to determine the possibilities of using artificial intelligence tools to support this process. To do this, it is advisable to consider the main components of engineering thinking and the role of AI in their formation, which is summarized in Table 2.8.

Table 2.8 reflects the main components of engineering thinking and the possibilities of using artificial intelligence tools to form them in the educational process of training technical specialists in specialties G3 and G7. The table systematizes the relationship between individual components of engineering thinking, AI functions, and expected educational outcomes.

Table 2.8

Shaping engineering thinking using artificial intelligence

Engineering Thinking Component	The role of AI	Educational outcome
Systemic vision	Knowledge integration	Comprehensive analysis
Analytical thinking	Data interpretation	Reasoned decisions
Project thinking	Analysis of alternatives	Optimal solutions
Reflection	Error Explanation	Introspection
Creative thinking	Variant generation	Innovation

The presented generalization allows us to consider artificial intelligence as an auxiliary tool for supporting educational activities, aimed at developing systemic, analytical and project thinking of higher education students. The use of AI in these areas contributes to improving the quality of engineering thinking formation without replacing independent intellectual and engineering activities of education students.

Examples of implementing an interdisciplinary approach:

- *Example 1. When designing an electric drive system, students apply knowledge of electrical engineering, mechanics, and automatic control theory. AI can help analyze the relationship between electrical parameters and mechanical characteristics of the system.*
- *Example 2. In robotics disciplines, AI is used to explain the relationship between kinematics, programming, and control algorithms, which helps showcase to learners the systemic nature of engineering solutions.*
- *Example 3. In interdisciplinary course projects, AI can be used to analyze options for implementing a technical solution from different perspectives, without replacing the independent engineering thinking of students.*

Interdisciplinary connections are a necessary condition for the formation of engineering thinking among higher education students in specialties G3 and G7. Their purposeful use in the educational process contributes to the integration of knowledge, the development of systemic and analytical thinking, and the preparation of specialists for solving complex engineering problems.

The use of artificial intelligence tools is considered as an auxiliary means of supporting interdisciplinary learning, which strengthens the analytical and design components of engineering thinking without reducing the role of independent activity of students.

SECTION 3. USE OF ARTIFICIAL INTELLIGENCE IN THE LECTURE PROCESS

The lecture process in technical education performs a system-forming function, as it ensures the formation of a holistic understanding of the theoretical foundations of engineering disciplines and lays the foundation for further practical activities of higher education students. In the context of the digitalization of education and the growing role of individualization of the educational process, the introduction of artificial intelligence tools as auxiliary means of increasing the efficiency of lecture classes is relevant.

This section examines the possibilities of using artificial intelligence in the lecture process for the purpose of preparing and structuring lecture materials, adapting educational content to the level of language training of education seekers, visualizing complex technical processes and models, and introducing interactive lecture elements. Particular attention is paid to the use of AI in the educational process of training foreign higher education seekers in G3 and G7 specialties.

3.1. PREPARATION AND STRUCTURING OF LECTURE MATERIALS USING AI

Preparation of lecture materials in technical disciplines requires a clear logical structure, correct use of terminology and consistent presentation of educational material. Electrical engineering disciplines, as well as automation and robotics disciplines, are characterized by a significant number of abstract concepts, mathematical dependencies and complex cause-and-effect relationships, which complicates the perception of the material, especially for foreign students.

Artificial intelligence tools can be used at the stage of preparing lectures as a means of auxiliary analytical and structuring support for the teacher. In particular, AI is advisable to use for logical structuring of the lecture topic, highlighting key concepts, forming the sequence of presentation of the material, and coordinating the lecture content with the learning outcomes defined by the educational program.

The use of AI allows the teacher to quickly analyze the volume and complexity of the lecture material, identify excessively overloaded fragments and correct them without simplifying the engineering content. At the same time, the final formation of lecture materials, selection of examples and definition of accents remain the responsibility of the scientific and pedagogical worker.

To summarize the possibilities of using artificial intelligence at the stage of preparing and structuring lecture materials, it is advisable to systematize the main functions of AI in accordance with the stages of lecture preparation and expected methodological results. This approach allows us to clearly present the areas of methodological support for the teacher, which is summarized in Table 3.1.

Table 3.1

Possibilities of using AI at the stage of preparing lecture materials

Lecture preparation stage	AI function	Methodological result
Analysis of the lecture topic	Identifying key concepts	Logical integrity of the material
Structuring content	Formation of the sequence of presentation	Clear lecture structure
Alignment with learning outcomes	Content compliance check	Competency orientation
Volume optimization	Detecting overloaded fragments	Rational amount of material
Preparing examples	Generation of typical scenarios	Increasing visibility

Table 3.1 reflects the main directions of using artificial intelligence tools at the stage of preparing and structuring lecture materials. The generalization of such capabilities allows us to consider AI as an auxiliary tool for methodological support of the teacher, aimed at improving the quality of the logical organization of the lecture and its compliance with learning outcomes.

Examples of using AI in lecture preparation:

- *Example 1. When preparing a lecture on the theory of electrical circuits, AI can be used to form a logical sequence of consideration of circuit elements and their operating modes, taking into account the increasing complexity of the material.*
- *Example 2. In lectures on the theory of automatic control, AI tools are useful for structuring material on system stability, quality indicators, and methods for synthesizing controllers.*
- *Example 3. For foreign students, AI can help the teacher pre-assess the linguistic complexity of the lecture text and correct the wording without losing engineering accuracy.*

The use of artificial intelligence tools at the stage of preparing and structuring lecture materials creates conditions for improving the methodological quality of the lecture process in technical education. The use of AI allows ensuring the logical sequence of presentation of educational material, consistency between individual structural elements of the lecture, and compliance of its content with the learning outcomes defined by educational programs for specialties G3 and G7.

Methodically balanced use of AI helps to optimize the volume and complexity of lecture material without simplifying engineering content, which is especially important in teaching technical disciplines with a high level of abstraction. Artificial intelligence tools allow you to identify excessively overloaded fragments of lectures, adjust the wording and sequence of presentation of the material, taking into account the logic of engineering thinking.

The use of AI is of particular importance in the context of preparing lectures for foreign higher education students, as it helps to increase the accessibility

of educational material without losing terminological accuracy. The use of AI at the preparatory stage of lectures allows the teacher to assess the linguistic and cognitive complexity of the material in advance and ensure more effective perception of lecture content.

In general, the use of artificial intelligence in the preparation and structuring of lecture materials should be considered as a tool for methodological support of the teacher's activities, which strengthens traditional approaches to organizing the lecture process and contributes to improving the quality of the educational process without replacing the teacher's pedagogical and scientific responsibility.

3.2. ADAPTATION OF EDUCATIONAL CONTENT TO THE LEVEL OF LANGUAGE TRAINING OF EDUCATION SEEKERS

Adaptation of educational content to the level of language training of education seekers is a necessary condition for effective organization of the lecture process in groups with foreign higher education seekers. Technical disciplines are characterized by the use of specialized terminology, complex syntactic constructions and abstract formulations, which can complicate the perception of educational material with an insufficient level of proficiency in the language of instruction.

Artificial intelligence tools can be used as auxiliary means to support the adaptation of educational content without simplifying its engineering content. In particular, AI is advisable to use for analyzing the linguistic complexity of lecture materials, selecting alternative formulations, explaining terms, and structuring the text taking into account the level of language training of education seekers.

It is important that the adaptation of educational content does not mean reducing the requirements for learning outcomes or simplifying the technical content of disciplines. The main task is to create conditions for the correct understanding of the educational material and the formation of educational and professional competencies in full.

The directions of adaptation of educational content given in Table 3.2 specify the above provisions regarding the use of artificial intelligence tools to take into account the level of language training of education seekers. The generalization of AI functions and relevant methodological results allows us to consider the adaptation of educational content as a purposeful and controlled process that ensures the accessibility of lecture material without simplifying its engineering content.

The presented systematization confirms the feasibility of using AI as an auxiliary tool to support the lecture process, aimed at forming the educational and professional competencies of foreign higher education applicants within the requirements of educational programs in specialties G3 and G7.

To summarize the possibilities of using artificial intelligence tools to adapt educational content to the level of language training of education seekers, it is advisable to systematize the main directions of such adaptation, AI functions, and expected methodological results, which are presented in Table 3.2.

Table 3.2

Possibilities of using AI to adapt educational content

Direction of adaptation	AI functions	Methodological result
Language complexity analysis	Detection of complex fragments	Clarity of the material
Adaptation of wording	Alternative explanations	Correct perception
Explanation of terms	Contextual explanations	Learning terminology
Text structuring	Logical division of material	Reducing cognitive load
Preparation of supporting materials	Glossaries, explanations	Support for independent work

Table 3.2 reflects the main directions of adaptation of educational content using artificial intelligence tools and allows us to consider AI as an auxiliary means of supporting the lecture process. Systematization of AI functions contributes to the targeted use of digital tools to ensure the accessibility of educational material without reducing the requirements for engineering training of education seekers.

Examples of using AI for content adaptation:

- *Example 1. When preparing lectures on electrical engineering disciplines, AI can be used to create short explanations for complex terms and formulas, making them easier to understand for foreign students.*
- *Example 2. In lectures on disciplines related to automation and robotics, AI can assist in generating glossaries of technical terms with contextual explanations.*
- *Example 3. For independent study of the material, AI can be used as a consulting tool that helps students clarify the meaning of terms without disrupting the structure of the lecture process.*

Adapting educational content to the level of language training of education seekers is an important component of ensuring the effectiveness of the lecture process in technical education, especially in the context of studying foreign higher education seekers. The complexity of technical terminology, the abstractness of engineering concepts, and the richness of lecture material require methodically balanced approaches to presenting information without reducing the requirements for learning outcomes.

The use of artificial intelligence tools allows for a systematic analysis of the linguistic complexity of educational content, the selection of correct alternative formulations, the explanation of specialized terms, and the logical structuring of lecture material. This approach helps reduce the linguistic and cognitive load on students, ensures correct understanding of educational material, and creates conditions for the full formation of educational and professional competencies.

Adaptation of educational content using AI is of particular importance in the context of education for foreign higher education students, as it allows taking into account the individual characteristics of language training without simplifying the

engineering content of disciplines. Methodically balanced use of AI in the lecture process contributes to increased motivation for learning, activation of cognitive activity and more effective assimilation of complex technical material.

In general, the adaptation of educational content using artificial intelligence tools should be considered as an important direction for improving the lecture process, which strengthens the role of the teacher, ensures that educational content corresponds to learning outcomes, and contributes to improving the quality of education in G3 and G7 specialties.

3.3. VISUALIZATION OF COMPLEX TECHNICAL PROCESSES AND MODELS

Visualization is one of the key didactic tools in the lecture process of technical education, since a significant part of the educational material is related to abstract physical processes, mathematical models and dynamics of technical systems. For higher education students, in particular foreign ones, the complexity of perception of such processes is increased by language factors and the need to simultaneously process formulas, graphs and theoretical explanations.

Artificial intelligence tools create additional opportunities for visualization of complex technical processes and models in the lecture process. The use of AI allows you to form clear graphical representations, gradually display changes in system parameters, and also connect mathematical dependencies with their physical content. This approach contributes to a deeper understanding of the educational material and the development of engineering thinking among students.

The use of visualization with AI support does not replace analytical processing of the material, but complements it, creating conditions for conscious assimilation of theoretical provisions and their further application in practical activities.

To summarize the possibilities of using artificial intelligence tools to visualize complex technical processes and models, it is advisable to systematize the main directions of such visualization, AI functions, and expected methodological results, which are given in Table 3.3.

Table 3.3

Using AI to visualize complex technical processes and models

Visualization direction	AI functions	Methodological result
Graphs and characteristics	Constructing and explaining graphs	Understanding dependencies
Mathematical models	Step-by-step interpretation	Awareness of physical content
Dynamic processes	Parameter change animation	Transient analysis
Flowcharts	Visual representation of systems	Systemic vision
Mode comparison	Visualization of alternatives	Reasoned conclusions

Table 3.3 reflects the main directions of using artificial intelligence tools for visualization of complex technical processes and models in the lecture process. Systematization of AI functions and corresponding methodological results allows us to consider visualization as a purposeful pedagogical tool that increases the clarity of educational material and contributes to the formation of engineering thinking of higher education students.

Examples of using AI-powered visualization:

- *Example 1. In lectures on the theory of electrical circuits, AI tools can be used to visualize vector diagrams of voltages and currents, which makes it easier to understand phase relationships.*
- *Example 2. In disciplines on the theory of automatic control, AI can be used to visually display transient processes when changing controller parameters, which helps to understand the impact of settings on control quality.*
- *Example 3. In robotics lectures, AI tools allow you to demonstrate kinematic diagrams of actuator motion, combining graphical representation with analytical explanations.*

In order to practically specify the recommendations for using artificial intelligence tools for visualization of complex technical processes and models in the lecture process, it is advisable to summarize the main methodological aspects of such activities, the corresponding actions of the teacher, the role of AI and the expected methodological results. The systematization of these provisions in tabular form allows teachers to provide clear guidelines for the practical implementation of visualization with the support of AI, which is presented in Table 3.4.

Given in Table 3.4 specify the mechanisms for using artificial intelligence tools to visualize complex technical processes and models in the lecture process. Such

Table 3.4

Practical recommendations for using AI to visualize complex technical processes and models in the lecture process

Methodological aspect	Practical actions of the teacher	The role of AI	Expected methodological effect
Phased submission of material	Break the process into logical stages (initial, transitional, steady state)	Formation of a consistent visualization	Better understanding of process dynamics
Relationship of the model to the physical content	Explain the influence of individual parameters on system behavior	Visual display of parameter changes	Understanding the physical nature of models
Comparison of operating modes	Demonstrate different options for settings or modes	Simultaneous visualization of alternatives	Formation of engineering analysis
Annotated demonstration	Accompany visualization with targeted explanations	Generation of graphs and animations	Focus on key aspects

Continuation of Table 3.4

Methodological aspect	Practical actions of the teacher	The role of AI	Expected methodological effect
Adaptation for foreign students	Minimize text, use universal notation	Visual models instead of verbal explanations	Reducing language load
Activation of cognitive activity	Ask predictive questions before the demonstration	Quick change of scenarios	Development of analytical thinking
Preventing passive perception	Combine visualization with calculations	Explanation of simulation results	Conscious assimilation of the material

systematization allows us to consider visualization not as an illustrative element, but as a purposeful didactic tool to support the formation of engineering thinking in students.

In the lecture process of technical education, visualization of complex processes and models is implemented mainly using specialized engineering software. Artificial intelligence tools in this context do not replace classical modeling tools, but are used to interpret results, automate parameter analysis, explain relationships, and support the work of the teacher and students.

To specify the practical aspects of using visualization of complex technical processes and models in the lecture process, it is advisable to consider examples of specialized software used in the training of specialists in specialties G3 and G7. Generalization of information on areas of application, types of visualized processes and methods of using artificial intelligence tools within such software allows us to move from general recommendations to specific methodological solutions, which is presented in Table 3.5.

Table 3.5

Software for visualizing technical processes and using AI

Software	Application area (G3 / G7)	What is visualized	How AI is used
MATLAB / Simulink	G3, G7	System dynamics, transient processes, regulators	Analysis of modeling results, explanation of the influence of parameters, generation of comments on graphs
ANSYS	G3	Electromagnetic and thermal processes	Interpretation of fields and characteristics, explanation of reasons for changes in results
PSCAD	G3	Power systems, emergency modes	Mode analysis, explanation of non-stationary processes
LTspice / Multisim	G3	Electrical circuits, signals	Oscillogram commenting, element influence analysis
TIA Portal (Siemens)	G7	Control algorithms, PLC	Explanation of program logic, error analysis

Continuation of Table 3.5

Software	Application area (G3 / G7)	What is visualized	How AI is used
ROS + Gazebo	G7	Robotic systems, motion	Trajectory analysis, explanation of robot behavior
SolidWorks Simulation	G3, G7	Mechanical and electromechanical systems	Interpretation of stresses, strains
Python (NumPy, Matplotlib)	G3, G7	Computational models, graphs	Explanation of algorithms, automatic analysis of results

Table 3.5 presents general examples of specialized software used in the lecture process of technical education for the visualization of complex technical processes and models within the framework of training specialists in specialties G3 and G7. The table systematizes the areas of application of the relevant software tools, the types of processes and models to be visualized, as well as the areas of use of artificial intelligence tools.

The presented generalization allows us to consider artificial intelligence not as a separate software product, but as an intellectual analytical and explanatory tool that complements traditional engineering modeling tools. The use of AI in combination with specialized software contributes to the interpretation of modeling results, a better understanding of cause-and-effect relationships, and increased clarity of lecture material without replacing the independent engineering activities of students.

In these software tools, AI is not a built-in simulator, but is used as an intelligent analytical and explanatory layer, which:

– interprets the results of numerical modeling;
– explains the reasons for changing schedules, fields, or characteristics;
– helps to compare different modeling scenarios;
– forms an explanation of the results in an accessible form for education seekers;
– supports the teacher when commenting on visualizations.

Practical examples of use:

- *Example 1 (G3, MATLAB/Simulink). During a lecture on automatic control theory, a transient process of a system is demonstrated. AI is used to explain how changing the controller gain affects overshoot and settling time, with an emphasis on the physical interpretation of the process.*
- *Example 2 (G3, ANSYS). When visualizing the electromagnetic field in an electrical machine, AI helps explain the causes of local field strength maxima and their impact on heating and losses.*
- *Example 3 (G7, TIA Portal). During a PLC program demonstration, AI is used to comment on the logic of the control algorithm and explain typical errors in the command sequence.*
- *Example 4 (G7, ROS + Gazebo). When modeling the movement of a mobile robot, AI helps analyze the trajectory, explain deviations from the given path, and the impact of control parameters.*

The use of visualization of complex technical processes and models in the lecture process is a necessary condition for effective mastering of educational material in technical education, in particular in specialties G3 and G7. The combination of classical engineering modeling tools with artificial intelligence tools allows to increase the clarity of the presentation, ensure the connection between mathematical models and their physical content, and also contribute to the development of systemic and analytical engineering thinking of education seekers.

The practical significance of using AI in visualization lies in the possibility of step-by-step presentation of complex processes, automated interpretation of modeling results, and comparative analysis of different operating modes of technical systems. This approach allows students to focus on key cause-and-effect relationships and patterns, which is important for developing the ability to make informed engineering decisions.

Visualization with the support of artificial intelligence tools is of particular importance in the context of education for foreign higher education students. The use of visual models, animations, and graphic representations allows reducing the language load, facilitating the perception of complex technical material, and ensuring equal conditions for the formation of educational and professional competencies without simplifying the engineering content of disciplines.

At the same time, the effectiveness of using AI for visualization largely depends on the methodological position of the teacher. Artificial intelligence tools should be used as an auxiliary tool to support explanatory and analytical activities, and not as an independent source of ready-made solutions. The combination of visualization with commenting, posing problem questions and involving students in discussing the results of modeling ensures the activation of cognitive activity and the improvement of the quality of the lecture process.

Thus, the methodically balanced use of artificial intelligence tools for visualization of complex technical processes and models is an effective direction for improving the lecture process in technical education, which contributes to the formation of engineering thinking, improving the quality of education, and achieving learning outcomes defined by educational programs in G3 and G7 specialties.

3.4. INTERACTIVE LECTURE ELEMENTS USING ARTIFICIAL INTELLIGENCE

Interactivity is an important characteristic of the modern lecture process in technical education, as it contributes to the activation of cognitive activity of students, the formation of a conscious understanding of the educational material and the development of analytical and engineering thinking. For technical disciplines, interactive elements allow moving from passive perception

of information to involving students in the process of analysis, forecasting and discussion of engineering solutions.

Artificial intelligence tools create additional opportunities for introducing interactive elements into the lecture process without violating its logical structure and without reducing academic requirements. The use of AI allows you to organize feedback in real time, simulate variable scenarios, analyze student responses, and adjust further presentation of the material.

For practical specification of forms of interactive interaction in the lecture process, it is advisable to summarize the main types of interactive elements, the possibilities of using artificial intelligence tools, and the expected methodological results, which are presented in Table 3.6.

Table 3.6

Interactive lecture elements using AI

Interactive element type	Practical implementation in lectures	The role of AI	Methodical effect
Problematic questions	Formulating predictive questions	Response analysis	Activation of thinking
Instant poll	Short test tasks	Summary of results	Feedback
Situation analysis	Discussion of engineering cases	Generation of alternatives	Engineering analysis
Variant scenarios	Changing system settings	Consequence modeling	Systems thinking
Group discussion	Forming conclusions	Structuring ideas	Awareness of the material

Table 3.6 shows the main types of interactive elements that can be integrated into the lecture process using artificial intelligence tools. The systematization of forms of interactive interaction allows us to consider AI as an auxiliary means of organizing active cognitive activity of students and supporting feedback within the lecture.

Practical recommendations for implementing interactive elements:

1. *Interactivity should be managed. The use of AI should not turn a lecture into a set of separate activities. Interactive elements should be planned in advance and logically linked to key points of the lecture.*
2. *Focus on engineering solutions. Interactive tasks should stimulate cause-and-effect analysis, rather than testing mechanical reproduction of the material.*
3. *Taking into account the language skills of foreign students. Interactive elements should be formulated using clear and concise questions, combining text with visual materials.*
4. *Combination with teacher explanations. The results of interactive interaction should be discussed and summarized by the teacher to form a holistic understanding of the material.*

Examples of using interactive elements:

- *Example 1. During a lecture on the theory of automatic control, the teacher asks students to predict the change in the transient process when changing the controller parameter. AI summarizes the answers and visualizes the results.*
- *Example 2. Lectures on electrical engineering disciplines use a short interactive survey on choosing the optimal operating mode of an electric machine, followed by a comment from the teacher.*
- *Example 3. When considering robotic systems, AI helps to model various scenarios of actuator movement according to student suggestions.*

Interactive AI lecture elements are implemented in practice through a combination of specialized engineering software, survey platforms, and intelligent tools for analyzing student responses. In this combination, AI performs the functions of analyzing, generalizing, interpreting, and adapting interactive interaction in real time.

For practical specification of the use of interactive lecture elements with the support of artificial intelligence tools, it is advisable to consider examples of software used in teaching technical disciplines in specialties G3 and G7. Generalization of information on the areas of application of such software tools, types of interactive elements and methods of using AI allows us to move from general methodological recommendations to specific practical solutions, which is presented in Table 3.7.

Table 3.7

Software tools for implementing interactive lecture elements using AI

Software	Scope of application (G3 / G7)	Interactive element	How exactly is AI used?
MATLAB Live Editor	G3, G7	Interactive calculations	Analysis of responses, explanation of modeling results
Simulink + Live Scripts	G3, G7	Changing parameters in real time	Commenting on the impact of parameters
Mentimeter / Slido	G3, G7	Instant poll	Summarizing responses, identifying trends
Python (Jupyter Notebook)	G3, G7	Interactive charts	Automatic analysis and explanation
ROS + RViz	G7	Interactive motion simulation	Trajectory analysis, comment on deviations
TIA Portal (Simulation)	G7	Interactive PLC analysis	Explanation of program logic
GeoGebra / Desmos	G3	Graphical interpretation of models	Interactive explanation of dependencies
ChatGPT-like AIs	G3, G7	Intelligent assistant	Explanation of answers, clarification of concepts

In the above software tools, artificial intelligence is not used for automatic training of students, but as:

– a tool for analyzing responses during interactive surveys;
– a means of operational generalization of results ;
– intelligent explanatory assistant for commenting on parameter changes;
– support for adapting the pace and depth of explanation.

Practical examples of use:

- *Example 1 (G3, MATLAB Live Editor). During an electrical engineering lecture, students are asked to change the parameters of an electrical circuit. AI analyzes the results of the calculations and helps explain why the current or voltage pattern has changed.*
- *Example 2 (G7, Simulink). The teacher changes the controller parameters in real time, and the students predict the result. The AI generalizes the predictions and compares them with the actual graphs.*
- *Example 3 (G7, ROS + RViz). During a robotics lecture, students suggest possible motion trajectories. AI helps analyze the stability of the motion and the causes of deviations.*
- *Example 4 (G3/G7, Mentimeter). A short interactive survey is conducted on choosing the optimal engineering solution. AI analyzes the responses and identifies common errors for further explanation by the teacher.*

Methodological recommendations for the teacher:

– use interactive tools selectively, not constantly;
– determine in advance the purpose of each interactive element ;
– combine interactivity with explanation and generalization;
– avoid overloading the lecture with digital activities;
– ensure an active role of the teacher as a moderator.

Interactive lecture elements, implemented using artificial intelligence tools and specialized software, contribute to the activation of cognitive activity of education seekers, the development of engineering thinking and the formation of the ability to analyze engineering situations in real time. The practical use of AI in interactive lecture elements provides operational feedback, supports the adaptation of explanations and enhances the methodological efficiency of the lecture process without reducing academic requirements.

CHAPTER 4. USE OF ARTIFICIAL INTELLIGENCE IN PRACTICAL AND LABORATORY CLASSES

Practical and laboratory classes are key forms of organizing the educational process in technical education, since it is within their framework that the formation of the ability to apply the results of training to solve engineering problems, perform calculations, analyze technical solutions and work with engineering software is ensured. For specialties G3 and G7, the practical component of the educational process is of decisive importance, since it is directly related to future professional activities.

The use of artificial intelligence tools in practical and laboratory classes is considered as an auxiliary means of supporting the educational activities of students and teachers. AI can be used to check the correctness of intermediate results, analyze typical errors, explain problem-solving algorithms, and support independent work of students without replacing engineering thinking and responsibility for decisions made.

4.1. SUPPORT FOR CALCULATION AND GRAPHIC WORK

Calculation and graphic works are an integral part of the practical training of higher education applicants in specialties G3 and G7, as they are aimed at developing the ability to perform engineering calculations, analyze technical dependencies and interpret results in graphical form. For foreign education applicants, performing such works is often complicated by a combination of high mathematical complexity and language barriers.

Artificial intelligence tools can be used to support the execution of calculation and graphic work as consulting and analytical tools. In particular, AI is advisable to use to explain calculation algorithms, check the logic of performing individual stages of work, analyze the correctness of graph construction, and identify typical errors in calculations.

It is important to emphasize that the use of AI in performing calculation and graphic work should not replace the independent completion of tasks by students. The main task is to support the process of understanding the calculation methodology and interpreting the results, and not to automatically obtain ready-made answers.

For practical specification of the possibilities of using artificial intelligence tools when performing computational and graphical work, it is advisable to summarize the main types of tasks, AI functions, and expected methodological results, which is presented in Table 4.1.

Table 4.1 systematizes the areas of use of artificial intelligence tools to support the performance of computational and graphical work within the framework of practical and laboratory classes. Generalizing the role of AI allows us to consider it

Table 4.1

Using AI to support computational and graphical work

Type of work	Typical actions education seeker	The role of AI	Methodological result
Engineering calculations	Sequential execution of formulas	Explanation of algorithms	Conscious execution
Checking the results	Intermediate data analysis	Detecting logical errors	Calculation correction
Graphing	Selecting scale and axes	Comment on the graphs	Correct visualization
Dependency analysis	Interpretation of results	Explanation of relationships	Engineering thinking
Self-control	Checking the work done	Feedback	Quality improvement

as an auxiliary tool of pedagogical support aimed at forming the ability to correctly perform engineering calculations and interpret the results obtained.

Examples of using AI in performing computational and graphical work:

- *Example 1 (G3). When performing electrical engineering calculations, AI can be used to explain the sequence of calculating electrical circuit parameters and verify the logic of the results obtained without providing ready-made answers.*
- *Example 2 (G7). In practical automation work, AI helps analyze the correctness of constructing graphs of transient processes and explain the impact of changing parameters on the shape of the graphs.*
- *Example 3 (foreign students). AI is used to clarify terminology and explain task formulations, which contributes to a more accurate understanding of the conditions of calculation work.*

In order to practically specify the use of artificial intelligence tools in performing computational and graphical work, it is advisable to summarize the main types of practical tasks, software, actions of education seekers and methods of involving AI in the educational process. Systematization of these aspects in tabular form allows us to clearly present the mechanisms of methodological support for the implementation of engineering calculations and graphical analysis, which is reflected in Table 4.2.

Table 4.2 summarizes the practical aspects of using software and artificial intelligence tools when performing computational and graphical work within the framework of practical and laboratory classes in specialties G3 and G7. The table systematizes the main types of practical work, relevant software, actions of education seekers and areas of AI involvement in the educational process.

The presented structure of the table allows us to consider artificial intelligence as a consulting and analytical tool to support educational activities, aimed at explaining the methodology of engineering calculations, analyzing the

Table 4.2

Using AI software and tools when performing computational and graphical work

Type of practical work	Software	Actions of the education seeker	How exactly is AI involved?	Methodological result
Calculation of DC electrical circuits	MATLAB, Python (NumPy), Excel	Calculation of currents, voltages, powers	Explanation of the calculation sequence, checking the logic of formulas	Conscious execution of calculations
Calculation of AC circuits	MATLAB, Python (SymPy)	Working with complex quantities	Analysis of phase relations, explanation of errors in complex calculations	Understanding the physical nature of processes
Construction of vector diagrams	MATLAB, Python (Matplotlib)	Construction of voltage and current diagrams	Commenting on the relative location of vectors	Correct interpretation of results
Transient analysis	MATLAB, Simulink	Construction of time characteristics	Explanation of the causes of overshoot and oscillation	Development of analytical thinking
Graphical analysis of dependencies	Python, GNU Octave	Building functional dependencies	Curve shape analysis, anomaly detection	Engineering interpretation of graphs
Calculation of regulator parameters (G7)	MATLAB / Simulink, Scilab	Setting parameters	Explanation of the impact of parameters on stability	Developing systems thinking
Self-monitoring of the work performed	All listed	Checking intermediate results	Identification of common mistakes, recommendations	Improving the quality of work
Support for foreign students	All listed	Clarification of task conditions	Explanation of terms and formulations	Reducing language difficulties

logic of task performance, and identifying typical errors. The generalization of methodological results emphasizes the feasibility of using AI to form the ability to interpret numerical and graphical results without replacing the independent engineering activities of education seekers.

The use of artificial intelligence tools to support the performance of computational and graphical work increases the efficiency of practical and laboratory classes, promotes the conscious performance of engineering calculations and the development of results analysis skills. Methodically balanced application of AI provides support for the independent work of education seekers without replacing engineering activities and meets the requirements of the competency-based approach in technical education.

4.2. APPLICATION OF ARTIFICIAL INTELLIGENCE IN MODELING ELECTRICAL AND AUTOMATED SYSTEMS

Modeling of electrical and automated systems is a central element of practical and laboratory training for students in the specialties G3 “Electrical Engineering” and G7 “Automation, Computer-Integrated Technologies and Robotics”. It is in the modeling process that the ability to move from abstract mathematical descriptions to the analysis of the behavior of real technical systems in different operating modes is formed.

The essence of modeling is not only in building a mathematical or simulation model, but primarily in understanding how changing parameters affects physical processes, energy characteristics, stability and dynamics of the system. In practice, students often encounter a situation where the model formally works, but the results obtained are not realized or interpreted incorrectly. The reason for this is the insufficient level of engineering thinking, and for foreign students – additional language and terminological difficulties.

The use of artificial intelligence in modeling electrical and automated systems is aimed at supporting analytical and interpretive activities, rather than automating the modeling process. AI acts as an intellectual tool that helps learners understand the content of the model, understand the reasons for the results obtained, and establish cause-and-effect relationships between system parameters and its behavior.

A key aspect of AI application is explaining the structure of the model. During laboratory sessions, students work with multi-component models that include electrical, mechanical, electronic, and software elements. AI is used to explain the role of each element of the model, the nature of its interaction with other components, and the limitations imposed on the model due to the assumptions made. This avoids mechanical copying of diagrams and promotes conscious modeling.

No less important is the role of AI in the interpretation of simulation results. The resulting time diagrams, transient graphs, or spatial distributions of parameters do not in themselves guarantee understanding. AI helps to explain why the system exhibits a certain response pattern, which parameters are decisive and which have a secondary effect. This approach forms the ability to analyze the results of a numerical experiment from the standpoint of engineering logic.

An important component of AI applications is the analysis of the sensitivity of the system to changes in parameters. In the modeling process, students change the parameters of electrical or automated systems and observe the consequences of these changes. AI is used to explain why a small change in one parameter can significantly affect the behavior of the system, while a change in another parameter has practically no effect on the results. This contributes to the formation of engineering intuition and systems thinking.

A separate aspect is the identification and analysis of typical modeling errors. Such errors include incorrect initial conditions, incorrect units

of measurement, incorrect connections of model elements, or incorrect interpretation of results. AI is used to identify such errors and explain their impact on modeling results, which is especially important when working with foreign students.

Thus, the essence of the application of artificial intelligence in the modeling of electrical and automated systems is to create a methodically controlled environment in which students not only perform laboratory work, but also learn to analyze, explain and interpret the results of modeling from the standpoint of engineering activity. It is this approach that provides a practical focus of laboratory classes and meets the goals of training specialists in specialties G3 and G7.

Modeling electrical and automated systems in practical and laboratory classes is a key stage in the formation of engineering training for students in specialties G3 and G7. It is at this stage that students move from theoretical concepts to analyzing the behavior of real technical systems, studying the influence of parameters, and evaluating the consequences of engineering decisions.

The essence of using artificial intelligence in modeling is not in automating model building, **but in** pedagogical support of engineering analysis, which includes:

– awareness of the model structure;
– understanding the physical meaning of the parameters;
– interpretation of modeling results;
– analysis of cause-and-effect relationships between parameters and system behavior.

In traditional modeling practice, students often focus on the formal reproduction of an algorithm: building a circuit, running the model, and obtaining graphs. In this approach, the modeling results are perceived as “correct” or “incorrect” without a deep understanding of the reasons for their occurrence. It is at this stage that it is appropriate to involve artificial intelligence tools as an analytical and explanatory mediator between the numerical result and its engineering content.

To generalize the essential functions of artificial intelligence, which are implemented in the process of analyzing typical errors during practical classes on modeling electrical and automated systems, it is advisable to systematize the relevant areas of use of AI, their content and pedagogical and engineering significance. Such generalization allows us to clearly present the role of artificial intelligence in supporting the analytical activity of students and the formation of engineering thinking, which is reflected in Table 4.3.

Table 4.4 systematizes the essential functions of artificial intelligence in practical classes on modeling electrical and automated systems and specifies the areas of its pedagogical and engineering application.

The presented functions reflect the key stages of students' work with models of technical systems – from understanding their structure to analyzing results and identifying errors.

Table 4.3

Essential functions of artificial intelligence in practical modeling exercises

The essential function of AI	Function content	Pedagogical and engineering significance
1. Explanation of the model structure	AI helps to understand the correspondence of model elements to real physical or technical components of the system, explains their functional purpose, the nature of interaction, and the assumptions embedded in the model.	Developing an understanding of the structure of a technical system, preventing mechanical copying of models
2. Interpretation of modeling results	AI is used to explain the nature of the resulting graphs, time diagrams, and spatial distributions of parameters, as well as to establish cause-and-effect relationships between model parameters and system behavior.	Development of the ability to analyze the results of a numerical experiment from the standpoint of engineering logic
3. Sensitivity analysis to parameters	AI helps to identify critical model parameters, analyze the impact of their changes on the stability, performance, energy and dynamic characteristics of the system	Developing systems thinking and engineering intuition
4. Identifying common modeling errors	AI identifies common errors related to initial conditions, model structure, units of measurement, and block connections	Improving the quality of modeling, reducing the number of errors, supporting foreign education seekers

Generalization of the essential functions of AI allows us to consider it as an auxiliary analytical and explanatory tool that supports the formation of engineering thinking, the ability to interpret modeling results and make sound technical decisions. This approach ensures the practical orientation of laboratory classes and meets the requirements for training specialists in G3 and G7 specialties, in particular in the conditions of training foreign students.

In order to practically specify the essential functions of artificial intelligence in the process of modeling electrical and automated systems, it is advisable to consider examples of their implementation using specialized engineering software. Generalization of information on relevant software environments, typical training situations and practical results of AI application allows us to move from a theoretical description of functions to specific methodological solutions, which is presented in Table 4.4.

The examples given demonstrate that artificial intelligence in practical modeling classes does not perform the function of a simulator, but is used as an intellectual explanatory and analytical tool that accompanies the activities of students at all stages of working with models.

Table 4.4

Implementing essential AI functions in modeling electrical and automated systems

The essential function of AI	Example of a software environment	Specific example of use	Practical result for the student
1. Explanation of the model structure	MATLAB / Simulink	AI explains that the Integrator, Gain, Sum blocks in the automatic control system model correspond to the physical elements of the real system (inertia, gain, feedback)	Awareness of the correspondence between the mathematical model and the real technical system
	PSCAD	AI explains the purpose of voltage sources, transformers, loads, and transmission lines in a power system model	Understanding the structure of the power system
	ROS	AI explains the interaction of nodes, topics, and messages in the structure of a robotic system	Forming an understanding of robotic software architecture
2. Interpretation of modeling results	MATLAB / Simulink	AI explains the reasons for overregulation and the oscillatory nature of the transient process after changing the regulator coefficients	Ability to explain the dynamics of a control system
	PSCAD	AI interprets time diagrams of currents and voltages during a short circuit in the network	Understanding emergency modes
	ROS + Gazebo	AI explains why a robot's trajectory deviates from the set one due to delays or incorrect control parameters	Robotic system behavior analysis
3. Sensitivity analysis to parameters	MATLAB / Simulink	AI analyzes the impact of changing PID controller parameters on settling time and stability	Formation of engineering intuition
	PSCAD	AI explains how changing load parameters affect power system operation modes	Understanding the relationship between system parameters
	ROS	AI analyzes the change in the robot's trajectory when changing speed or control coefficients	Understanding the impact of parameters on movement
Identifying common modeling errors	MATLAB / Simulink	AI points out incorrect initial conditions or incorrect connection of blocks in the model	Eliminating logical and structural errors
	PSCAD	AI detects errors in measurement units or network element parameters	Improving modeling accuracy
	ROS	AI helps find errors in node interactions or sensor settings	Stable operation of the robotic system

The use of AI allows you to connect the formal elements of models with the physical content of processes, ensure informed interpretation of results, and reduce the number of typical errors, which is especially important in the preparation of foreign students.

Modeling of electrical and automated systems is one of the basic forms of practical training for higher education students in specialties G3 and G7. It provides the formation of the ability to analyze the behavior of technical systems, investigate their characteristics, evaluate the influence of parameters and predict the results of work in different modes. For foreign students, modeling also serves as an effective means of reducing the language load due to the clarity and formality of engineering models.

Artificial intelligence tools in the modeling process should be used as auxiliary analytical and explanatory tools that support understanding of the model structure, interpretation of results, and analysis of typical errors. At the same time, AI does not replace modeling software environments, but complements them at the level of explanation, analysis, and methodological support.

For practical specification of the application of artificial intelligence in modeling electrical and automated systems, it is advisable to summarize the software used, types of models, actions of students and methods of involving AI, which is presented in Table 4.5.

Table 4.5 reflects practical approaches to the use of artificial intelligence tools in the process of modeling electrical and automated systems during

Table 4.5

Using AI in modeling electrical and automated systems

System type	Software	Actions of the education seeker	How AI is involved	Practical result
Electrical circuits	MATLAB / Simulink, LTspice	Building a circuit, setting parameters	Explaining the model structure, checking the logic of connections	Conscious modeling
Energy systems	PSCAD	Analysis of operating modes	Interpretation of transient processes	Analysis of non-stationary regimes
Automatic control systems	MATLAB / Simulink	Adjusting the controls	Explanation of the influence of parameters	Formation of synthesis skills
Electrome-chanical systems	Simscape	Modeling the interaction of subsystems	Analysis of the relationship between electrical and mechanical parameters	Systems thinking
Robotic systems	ROS + Gazebo	Motion simulation	Trajectory and stability analysis	Engineering interpretation
PLC systems	TIA Portal (Simulation)	Algorithm testing	Explanation of program logic	Trouble-shooting

practical and laboratory classes in specialties G3 and G7. The table systematizes the types of technical systems, relevant software, typical actions of students and areas of AI involvement at different stages of modeling.

The presented generalization allows us to reveal the essence of using artificial intelligence as an auxiliary analytical and explanatory tool used to interpret modeling results, analyze system behavior, and identify typical errors in model building. The table demonstrates that AI does not replace the engineering modeling process, but provides methodological support for students in developing the ability to analyze and explain the results of numerical experiments.

Thus, Table 4.5 specifies the practical focus of using AI in laboratory classes and emphasizes its role in the formation of engineering thinking and educational and professional competencies in accordance with the requirements of educational programs in specialties G3 and G7.

Table 4.3 does not simply list software. Its essence is that it:

– shows where in the modeling process the need for AI arises ;

– distinguishes between the engineering activity of the education seeker and the supporting role of AI ;

– demonstrates that AI is applied after or in parallel with the applicant's actions, rather than instead of them;

– emphasizes the practical focus of laboratory classes.

For foreign students, modeling is often a more accessible form of learning activity than textual or verbal analysis. However, without methodological support, the results of modeling remain "incomprehensible pictures."

The use of AI allows:

– compensate for language difficulties through model-based explanations;

– focus on the engineering essence of processes;

– to ensure the gradual formation of engineering thinking regardless of the level of language training.

Artificial intelligence **should NOT:**

– automatically build models;

– optimize parameters without the applicant's participation;

– to issue ready-made conclusions.

Artificial intelligence **MUST:**

– explain;

– analyze;

– ask clarifying questions;

– to guide engineering thinking.

Table 4.3 shows practical scenarios for using artificial intelligence tools in modeling electrical and automated systems within practical and laboratory classes. The presented systematization demonstrates that AI is used mainly at the stages of explaining the structure of models, analyzing results, and identifying typical errors, which contributes to the formation of the ability to engineer the interpretation of modeling results.

Practical examples of use:

- *Example 1 (G3, MATLAB / Simulink). During an electrical engineering lab, a student models an electrical circuit with variable parameters. AI is used to explain the effect of changing resistance or inductance on the current and voltage waveform without automatically adjusting the model.*
- *Example 2 (G7, MATLAB / Simulink). When studying an automatic control system, AI helps interpret the change in the transient response when adjusting the controller coefficients and explains the reasons for the loss of stability.*
- *Example 3 (G7, ROS + Gazebo). When simulating the movement of a mobile robot, students change the control parameters. AI analyzes the resulting trajectories and helps explain the reasons for deviations from the given route.*

For effective implementation of modeling using AI, it is advisable to use:

– licensed or educational software (MATLAB, PSCAD, TIA Portal, ROS);
– methodological instructions for laboratory work;
– examples of basic models for self-modification;
– instructions for analyzing simulation results;
– recommendations for using AI as an explanatory tool.

Analysis of errors made by education seekers during practical and laboratory classes, is an important component of the educational process in technical education. It is through working with errors that a deepening of understanding of engineering principles occurs, the formation of the ability to self-control and the development of engineering thinking occurs. For specialties G3 and G7, errors have not only an educational, but also a professional dimension, since in real engineering activities they can lead to serious technical and safety consequences.

Typical errors of students in practical and laboratory work are systemic and are often associated not with a lack of formal knowledge, but with insufficient understanding of the physical nature of processes, the logic of control algorithms or the relationships between elements of technical systems. For foreign students, these difficulties are further complicated by language and terminology barriers, which can lead to incorrect interpretation of task conditions and work results.

The essence of using artificial intelligence in the analysis of typical errors is to create a controlled analytical environment in which the error is considered not as a formal inconsistency of the result, but as a source of learning information. AI allows you to systematize errors, identify repeating patterns, explain their causes and demonstrate the consequences of such errors for the functioning of technical systems.

One of the key areas of application of AI is error classification. In the process of performing laboratory work, AI can analyze the actions of students, compare them with reference algorithms and detect deviations characteristic of certain types of tasks. This allows you to distinguish between conceptual errors (incorrect understanding of the principle of operation of the system), algorithmic errors

(violation of the logic of actions) and technical errors (incorrect parameters, units of measurement, connections).

An important function of AI is to explain the causes of errors. Unlike traditional verification, which often boils down to fixing the correctness or incorrectness of the result, AI allows you to trace at what stage the error occurred and what assumptions or actions led to it. This is especially important in complex engineering tasks, where the error may not appear immediately, but only at the stage of analyzing the results.

AI is also used to demonstrate the consequences of errors. In the process of modeling or programming, students can see how an incorrect parameter setting, incorrect algorithm logic, or incorrect connection of elements leads to unstable system operation, an emergency mode, or incorrect behavior of the controlled object. This approach contributes to the awareness of the responsibility of engineering decisions.

Of particular importance is the use of AI to develop self-control and self-analysis skills. AI can be used as a tool for preliminary verification of the results of the work of education seekers, providing feedback in the form of prompts, questions or recommendations for checking individual elements of the work. In this case, the responsibility for correcting errors remains with the education seeker, which is consistent with the principles of academic integrity.

Thus, the analysis of typical errors with the involvement of artificial intelligence allows us to move from formal evaluation of results to a deep analysis of the process of performing engineering tasks. This creates conditions for conscious assimilation of educational material, development of engineering thinking, and improvement of the quality of practical training of students in G3 and G7 specialties.

4.3. USING ARTIFICIAL INTELLIGENCE IN PROGRAMMING CONTROLLERS AND ROBOTIC SYSTEMS

Programming programmable logic controllers and robotic systems is one of the most complex and responsible components of the practical training of students in the specialty G7 "Automation, Computer-Integrated Technologies and Robotics", as well as an important element of the formation of applied engineering skills within the specialty G3 "Electrical Engineering". It is in the programming process that the connection between algorithmic solutions and the physical behavior of technical objects under control is realized.

The essence of programming controllers and robotic systems is not in the formal creation of program code, but in the design of the logic of controlling technical processes, taking into account operating modes, interaction of actuators, feedback signals and safety requirements. Within the framework of practical and laboratory classes, students must learn to analyze technological processes, formalize them in the form of algorithms and implement these algorithms using industrial or robotic software.

The use of artificial intelligence in PLC and robotics programming is considered as a tool for methodological and analytical support, rather than as a means of automatic program creation. AI is used to support the process of designing control algorithms, explaining the logic of program solutions, analyzing errors, and assessing the consequences of implemented algorithms for the operation of a technical system.

One of the key areas of AI use is explaining the algorithmic logic of control programs. During practical classes, students work with algorithms implemented in the form of relay-contact circuits, functional blocks or program code. AI is used to explain the sequence of command execution, the conditions for transition between system states and the interaction between individual parts of the program. This avoids formal copying of typical solutions and contributes to the formation of a conscious approach to programming.

An important aspect is the analysis of logical errors in control programs. Unlike syntax errors, which are usually detected automatically by software environments, logical errors require a deep analysis of the algorithm and understanding of the system's behavior. AI is used to identify such errors, explain the reasons for their occurrence, and demonstrate how they affect the operation of the controlled object. This is of particular importance for the formation of responsible engineering thinking.

In robotic systems, the use of AI acquires additional importance due to the complexity of spatial and dynamic processes. Programming the movement of robots is associated with the choice of trajectories, speed parameters and control algorithms. AI is used to analyze the behavior of a robotic system, explain the reasons for deviations from the given trajectories and assess the stability of movement. This approach allows students to realize that even formally correct program code can lead to undesirable robot behavior due to incorrect parameters or control logic.

Within the framework of practical and laboratory classes in automation, electrical engineering, and robotics, control programs should be understood as algorithmic descriptions of the logic of the functioning of technical systems, implemented in the form of program code or graphic diagrams and intended for controlling actuators, electric drives, technological processes, and robotic objects.

Control programs are a key element in the implementation of engineering solutions, as they provide the conversion of input signals (data from sensors, control commands, environmental conditions) into control actions in accordance with specified algorithms, operating modes and safety requirements. In the context of obtaining education in specialties G3 and G7, control programs are considered not as a set of syntactic constructs, but as a formalized description of the engineering logic of the operation of a technical system.

Control programs used in the educational process include programs implemented in programmable logic controller programming environments, control system modeling environments, as well as software algorithms for controlling robotic systems created using general-purpose programming languages. It is with such control programs that students work in the process of performing

practical and laboratory work, forming the ability to analyze, design and improve control algorithms for technical objects.

Artificial intelligence in this context is not a control program, but is used as an auxiliary analytical and explanatory tool that supports the process of understanding program logic, error analysis, and interpretation of the results of controlled systems.

In order to generalize the terminological provisions regarding control programs used in practical and laboratory classes, as well as to systematize the relevant software, educational tasks and the role of artificial intelligence in the programming process, it is advisable to present a general classification. Such a presentation allows us to clearly outline the relationship between the types of control programs and the possibilities of using artificial intelligence tools in the educational process, which is reflected in Table 4.6.

The presented classification allows to clearly distinguish the types of control programs used in practical and laboratory classes, and to determine the role of artificial intelligence as a tool for methodological and analytical support of the programming process. This approach ensures the conscious formation of algorithmic and engineering thinking of students in G3 and G7 specialties.

In order to generalize the main types of control programs used in practical and laboratory classes in specialties G3 and G7, as well as to determine the educational tasks of students and the role of artificial intelligence in the

Table 4.6

Types of management programs, software, educational tasks and the role of artificial intelligence

Control program type	Software	Educational task	The role of artificial intelligence
Industrial control programs (PLC)	TIA Portal, Codesys	Design of algorithms for controlling technological processes, electric drives, and protection systems	Explanation of algorithm logic, analysis of command execution sequence, detection of logical errors
Programs for controlling electric drives and regulators	MATLAB / Simulink, Simscape	Regulator tuning, analysis of system dynamics and stability	Interpretation of transient processes, sensitivity analysis of parameters
Control programs in simulation	MATLAB / Simulink, PSCAD	Study of operating modes, emergency situations	Explanation of model structure and simulation results
Robotic systems control programs	ROS, Gazebo, Python	Programming of movement, navigation and interaction of the robot with the environment	Trajectory analysis, explanation of deviations and instability of movement
Control algorithms in programming languages	Python, C++	Implementing control at the program code level	Program logic analysis, debugging support

programming process, it is advisable to systematize the relevant information. Such generalization allows us to clearly present the engineering essence of control programs and the directions of involving artificial intelligence tools, which is reflected in Table 4.7.

Table 4. 7 systematizes the types of control programs used in practical and laboratory classes in specialties G3 and G7, and reveals their engineering essence in the context of the educational process. The generalization demonstrates that control programs are a key tool for implementing engineering solutions, and artificial intelligence in this process performs an auxiliary analytical and explanatory function, supporting the formation of algorithmic and engineering thinking of students.

Table 4.7

Control programs used in practical and laboratory classes and the role of artificial intelligence

Type of control programs	Software	The essence of the control program	Educational tasks of education seekers	The role of artificial intelligence
Industrial control programs (PLC)	TIA Portal, Codesys, EcoStruxure	Algorithms for controlling technological processes, electric drives, and actuators, taking into account operating modes and emergency situations	Design of control logic, implementation of start, stop, and protection algorithms	Explanation of algorithm logic, error analysis, interpretation of decision consequences
Programs for controlling electric drives and regulators	MATLAB / Simulink, Simscape	Algorithms for speed, torque, voltage, current control	Setting controller parameters, analyzing system dynamics	Sensitivity analysis of parameters, explanation of transient processes
Robotic systems control programs	ROS, Gazebo, RViz	Algorithms for controlling movement, orientation, and interaction of a robot with the environment	Trajectory formation, motion control, robot behavior analysis	Interpreting trajectories, explaining deviations and instability
Control programs in simulation	MATLAB / Simulink, PSCAD	Control algorithms implemented as models for studying system behavior	Analysis of operating modes, stability testing, investigation of emergency situations	Explanation of model structure and simulation results
Control algorithms in programming languages	Python, C++ (in ROS, simulators)	Algorithmic implementations of control logic and signal processing	Implementing control at the code level	Program logic analysis, error detection

A separate role is played by the use of AI for the gradual complication of control algorithms. In the process of obtaining education, students move from simple programs to complex integrated systems. AI can be used to analyze already implemented solutions, identify weak points of the algorithm and form recommendations for its improvement without automatically rewriting the program code. This contributes to the development of skills for independent design and optimization of control algorithms.

In the context of teaching foreign students, the use of artificial intelligence in programming controllers and robotic systems also performs a compensatory function, helping to reduce the impact of language barriers by explaining the logic of algorithms, the conditions for executing commands, and the results of program work in a formalized and visual form.

Thus, the essence of using artificial intelligence in programming PLCs and robotic systems is to create a methodically managed educational environment in which students develop the ability to design, analyze, and improve algorithms for controlling technical systems, realizing the responsibility of engineering decisions and their impact on the functioning of real objects.

For practical specification of the use of software in programming controllers and robotic systems, it is advisable to summarize typical educational tasks, actions of students and directions of involving artificial intelligence tools in the educational process. Systematization of these aspects allows us to clearly present practical scenarios for the use of TIA Portal and ROS in combination with the Python programming language, which is reflected in Table 4.8.

Table 4.8 specifies practical scenarios for using TIA Portal and ROS + Python software in programming controllers and robotic systems within practical and laboratory classes. The examples given demonstrate that artificial intelligence is used as a tool for analytical and explanatory support, which contributes to the formation of algorithmic and engineering thinking of students without replacing their independent engineering activities.

Table 4.8 shows practical scenarios for using TIA Portal and ROS software in combination with the Python programming language during practical and laboratory classes on programming controllers and robotic systems. The table systematizes control objects, the nature of educational tasks, actions of students and areas of involvement of artificial intelligence tools, which allows revealing the engineering essence of control programs in the educational process.

The examples given demonstrate that control programming in technical education involves not only the creation of formally correct program code, but also the conscious design of the logic of technical systems, analysis of operating modes, and evaluation of the consequences of algorithmic decisions made.

The use of artificial intelligence within such tasks is aimed at explaining algorithmic logic, analyzing the sequence of command execution, and identifying logical errors, which is critically important for the formation of responsible engineering thinking.

Table 4.8

Examples of using software in programming controllers and robotic systems

Software	Management object	Nature of the learning task	Actions of education seekers	The role of artificial intelligence	Practical result
TIA Portal (PLC)	Electric drive, technological installation	Programming the start, stop and protection algorithm	Development of control logic, setting of triggering conditions, testing of the program	Explanation of algorithm logic, analysis of command execution sequence, detection of logical errors	Conscious PLC programming and understanding of the behavior of the controlled object
TIA Portal (PLC)	Automated process	Implementation of a sequential algorithm	Construction of relay-contact circuits or functional blocks	Analysis of state transitions, explanation of emergency scenarios	Formation of algorithmic thinking
ROS + Python	Mobile robot	Motion and navigation programming	Implementation of the motion algorithm, processing of data from sensors	Interpretation of the trajectory, explanation of the reasons for deviation	Understanding the relationship between code and robot behavior
ROS + Python	Robotic system	Analysis of trajectories and stability of movement	Setting control parameters, testing algorithms	Analysis of the impact of parameters on movement, detection of logic errors	Formation of engineering thinking
ROS + Python	Simulated environment	Debugging control algorithms	Analysis of modeling results	Explaining the causes of unstable behavior	Conscious improvement of algorithms

Special attention in Table 4.8 is paid to robotic systems, which are characterized by complex interaction of program code with spatial and dynamic parameters of motion. The involvement of AI in this context allows interpreting motion trajectories, explaining the reasons for deviations from given routes, and analyzing the stability of robot behavior, which strengthens the practical focus of training in the G7 specialty.

Thus, Table 4.8 specifies the role of software and artificial intelligence tools in programming controllers and robotic systems, emphasizing their importance as means of methodological and analytical support aimed at forming algorithmic and engineering thinking of students and improving the quality of their practical training.

4.4. ANALYSIS OF TYPICAL MISTAKES OF EDUCATION SEEKERS WITH THE INVOLVEMENT OF ARTIFICIAL INTELLIGENCE

Analysis of typical errors of students is an integral part of practical training in the field of electrical engineering, automation and robotics. Errors that arise in the process of performing practical and laboratory classes are systemic in nature and, as a rule, are associated not only with an insufficient level of training, but also with the peculiarities of the formation of engineering thinking, the complexity of technical objects and the multi-level nature of control algorithms.

In the context of the educational process in the specialties G3 and G7, typical errors of students occur at the stages of modeling, control programming, parameter setting and interpretation of the results of the operation of technical systems. Often these errors are not obvious and manifest themselves only in the form of unstable system operation, incorrect modes or unexpected behavior of the controlled object. For foreign students, the complexity of error analysis is additionally due to language and terminological difficulties, which complicates the understanding of cause-and-effect relationships.

The essence of the analysis of typical errors with the involvement of artificial intelligence is the transition from formal control of results to the analysis of the process of performing an engineering task. Artificial intelligence in this case is used as an analytical and explanatory tool that helps to identify the nature of the error, localize the stage of its occurrence and explain its impact on the functioning of the technical system.

One of the key areas of application of AI is the systematization of typical errors. In the process of performing practical work, AI allows grouping errors by their nature: conceptual (incorrect understanding of the principle of operation of the system), algorithmic (violation of control logic), parametric (incorrect choice of settings), structural (errors in connecting elements) and interpretative (incorrect interpretation of results). Such systematization creates the basis for targeted correction of the educational process.

An important aspect is explaining the causes of errors, not just fixing them. AI is used to analyze the logic of the learner's actions, compare it with reference algorithms, and explain which assumptions or actions led to the error. This allows learners to understand that even minor deviations in the algorithm or parameters can significantly affect the behavior of a technical system.

A separate role is played by the analysis of the consequences of errors. Through modeling or simulation, AI allows you to demonstrate what operating modes or emergency situations a specific error can lead to. This approach has important educational and professionally oriented value, as it contributes to the formation of a responsible attitude towards engineering decisions.

The use of artificial intelligence in the analysis of typical errors also contributes to the formation of self-control and reflection skills. AI can be used as a means of preliminary analysis of work results, providing recommendations for checking individual elements of the model or program without automatic

error correction. This is consistent with the principles of academic integrity and promotes independent learning of the educational material.

Thus, the analysis of typical errors of education seekers with the involvement of artificial intelligence is an effective tool for improving the quality of practical training, which allows you to transform an error from a negative result into a source of educational information and an important element of the formation of engineering thinking.

To generalize the main types of errors that students make during practical and laboratory classes, as well as to determine the possibilities of their analysis and pedagogical processing with the involvement of artificial intelligence tools, it is advisable to systematize the relevant examples and areas of use of AI. Such generalization allows us to clearly present the relationship between the nature of errors, methods of their analysis and educational results, which is reflected in Table 4.9.

Table 4.9

Typical mistakes of education seekers and the possibilities of their analysis with the involvement of AI

Error type	Manifestation in practical classes	Example environment (software)	How AI is used	Educational outcome
Conceptual	Misunderstanding of the system's operating principle	Simulink	Explanation of the physical nature of the model elements and their interactions	Understanding the principles of system functioning
Algorithmic	Violation of control logic	TIA Portal (PLC)	Analysis of command execution sequence, detection of incorrect conditions	Formation of algorithmic thinking
Parametric	Incorrect choice of controller coefficients	Simulink	Sensitivity analysis of parameters and their impact on system dynamics	Development of engineering intuition
Structural	Errors in connecting elements or blocks	PSCAD, Simulink	Identifying model structure inconsistencies	Improving modeling quality
Interpretive	Misinterpretation of graphs and results	Simulink	Explanation of cause and effect relationships	Development of analytical skills
Logical-spatial	Deviation of the robot's trajectory	ROS + Python	Analysis of robot trajectories and behavior in the environment	Understanding the relationship between code and movement
Terminological	Misinterpretation of the assignment conditions	All environments	Explanation of technical terms and formulations	Support for foreign students

Table 4.9 summarizes the main types of errors that students make during practical and laboratory classes in electrical engineering, automation, and robotics, and also reflects the possibilities of their analysis and pedagogical processing with the involvement of artificial intelligence tools. The table systematizes typical learning situations, areas of AI use, and expected educational outcomes, which allows us to consider errors as an important component of the process of obtaining engineering education.

The presented generalization demonstrates that the involvement of artificial intelligence in error analysis contributes to the transition from formal control of results to a deep analysis of the causes of their occurrence. The use of AI allows you to identify recurring errors, explain their engineering essence and demonstrate the consequences of such errors for the functioning of technical systems. This is of particular importance in working with foreign students, for whom typical errors are often associated with a lack of understanding of terminology or task conditions.

Thus, Table 4.9 specifies practical mechanisms for using artificial intelligence to analyze typical errors and emphasizes its role as a tool for analytical and explanatory support aimed at forming engineering thinking, self-control skills, and a responsible attitude towards making technical decisions.

CHAPTER 5. ORGANIZATION OF INDEPENDENT WORK OF STUDENTS USING AI

5.1. PREPARATION FOR CURRENT AND FINAL CONTROL USING ARTIFICIAL INTELLIGENCE

The organization of independent work of students in preparation for current and final control is an important element of the educational process in a higher education institution. For specialties G3 "Electrical Engineering" and G7 "Automation, Computer-Integrated Technologies and Robotics", such training involves not only the reproduction of theoretical provisions, but also the ability to apply knowledge to analyze technical situations, solve engineering problems and explain the results of practical activities.

In the context of self-training for knowledge control, artificial intelligence is considered as an auxiliary tool for organizing and supporting learning activities, and not as a means of automatically obtaining answers. The main role of AI is to create conditions for conscious repetition of material, structuring knowledge and self-monitoring of the level of its assimilation.

Current control in technical disciplines usually includes checking the understanding of theoretical foundations, the ability to perform calculation tasks, analyze schemes, models and control algorithms. During independent preparation for such control, AI tools can be used to clarify concepts, explain the logic of solving typical engineering problems and analyze the correctness of the calculations performed. It is important that AI does not replace the process of solving problems, but contributes to the awareness of the sequence of actions and cause-and-effect relationships.

Final control (exam, test, final certification) requires students to have a systemic vision of the educational material, the ability to integrate knowledge from different topics and disciplines, and to explain engineering solutions in a reasoned manner. In this context, AI can be used to structure educational material, form generalized schemes and logical connections between topics, as well as for self-testing readiness for control.

The use of artificial intelligence in preparation for testing is of particular importance for foreign students. AI can be used to explain technical terminology, clarify the wording of test questions and tasks, and overcome language barriers when processing complex educational material. This helps to increase the accessibility of educational content without reducing the requirements for the level of training.

At the same time, in the process of organizing independent preparation for current and final control, it is necessary to strictly adhere to the principles of academic integrity. The use of AI should be aimed at explanation, analysis and self-testing, and not at obtaining ready-made answers to control questions or completing tasks instead of the student. This approach allows you to maintain

the leading role of independent cognitive activity and ensures the objectivity of assessing learning outcomes.

Thus, the use of artificial intelligence in preparation for current and final control is an effective means of supporting the independent work of education seekers, which contributes to a deeper assimilation of educational material, the formation of systemic thinking, and the improvement of the quality of educational results in specialties G3 and G7.

In order to generalize the main forms of current and final control, the features of independent preparation of education seekers and the possibilities of using artificial intelligence tools, it is advisable to systematize the relevant approaches in tabular form. Such generalization allows us to clearly present the directions of application of AI for organizing independent work and self-control during preparation for assessment, which is reflected in Table 5.1.

Table 5.1

AI software and tools in preparing students for current and final examinations

Type of control	Form of preparation	AI software/ tools	Specific actions of education seekers	Practical effect
Current control (theoretical surveys, tests)	Repetition and clarification of theoretical provisions	Generative AI systems (language models), electronic learning platforms	Clarification of concepts, translation and explanation of technical terminology, examples of application of formulas	Conscious assimilation of theoretical foundations
Current control (calculation tasks)	Independent preparation for solving problems	MATLAB, Mathcad, Python (in combination with AI explanations)	Checking the sequence of calculations, error analysis, interpretation of results	Developing engineering calculation skills
Current control (laboratory work)	Preparation for laboratory classes	MATLAB/ Simulink, PSCAD, AI-enabled modeling environments	Analysis of the model structure, preparation of the work execution algorithm	Improving the quality of laboratory work
Final test (test)	Systemati-zation of educational material	Intelligent assistants for text structuring, learning platforms	Building logical diagrams, generalizing topics, interdisciplinary connections	Systemic vision of educational material
Final test (exam)	Comprehen-sive training	AI for self-testing, training test environments	Independent processing of typical questions, analysis of errors	Readiness for reasoned answers
Final test (practical exam)	Preparation for practical tasks	TIA Portal (PLC), ROS + Python, Simulink	Development of typical engineering scenarios, analysis of control logic	Ability to apply knowledge in practical situations

In the process of preparing for current and final control, software with elements of artificial intelligence is used by students as a means of explanation, analysis and self-checking. At the same time, performing calculations, building models and making engineering decisions remain the result of independent activity of students, which meets the requirements of academic integrity.

Table 5.1 systematizes the main forms of current and final control in higher technical education and reflects the possibilities of using software and artificial intelligence tools in organizing independent training of education seekers. The table summarizes the types of control, relevant forms of training, software tools used in educational activities, as well as specific actions of education seekers and expected practical results.

The presented software examples demonstrate that artificial intelligence tools are integrated into the preparation for control mainly as means of explanation, analysis and self-testing. In particular, AI language systems are used to clarify technical terminology, explain theoretical provisions and structure educational material, while engineering software environments (MATLAB, Simulink, PSCAD, TIA Portal, ROS) provide verification of the correctness of calculations, analysis of models and practice of practical engineering scenarios.

Table 5.1 highlights that effective preparation for ongoing and final examinations requires a combination of different types of software depending on the nature of the tasks. This approach contributes to the formation of a systematic vision of the educational material, the development of skills of independent analysis and the responsible use of digital tools in the process of obtaining education.

Thus, the above generalization confirms the feasibility of using software with elements of artificial intelligence as a component of methodological support for the independent work of students in G3 and G7 specialties, while simultaneously adhering to the principles of academic integrity and preserving the leading role of independent cognitive activity.

5.2. DEVELOPING SELF-LEARNING AND CRITICAL THINKING SKILLS USING ARTIFICIAL INTELLIGENCE

The formation of self-study and critical thinking skills is one of the key goals of modern higher technical education and an important condition for successful completion of education in the specialties G3 “Electrical Engineering” and G7 “Automation, Computer-Integrated Technologies and Robotics”. In the context of rapid technology and software updates, students must be able to independently master new knowledge, analyze technical information, and evaluate the validity of engineering solutions.

Self-study in technical disciplines involves not only independent study of educational materials, but also active cognitive activity associated with the search for information, analysis of various approaches to solving engineering problems and critical reflection of the results obtained. Critical thinking, in turn,

is manifested in the ability to check the correctness of assumptions, assess the reliability of information sources, identify logical errors and defend one's own engineering solutions with arguments.

The use of artificial intelligence in the formation of self-study and critical thinking skills is considered as a tool to support reflective and analytical activities, and not as a source of ready-made answers. AI can be used to structure educational material, ask clarifying questions, compare alternative solutions and analyze the logic of students' reasoning. This approach contributes to the development of a conscious attitude to the learning process.

An important aspect is the use of AI to organize individual self-paced learning. Students have different levels of basic training, experience with software and proficiency in the language of instruction. AI can be used to adapt explanations, clarify terminology and select examples according to individual educational needs, which is especially relevant for foreign students.

In the process of developing critical thinking, AI is useful for analyzing alternative engineering approaches. For example, when solving a technical problem, a student can compare different calculation, modeling, or control methods, analyze their advantages and limitations. In this case, AI acts as a tool that helps ask the right questions, identify weak points in the argument, and assess the consequences of decisions.

Special attention should be paid to the use of AI for reflection on the results of independent work. Artificial intelligence tools can be used to analyze completed tasks, identify typical errors in reasoning, and generate recommendations for further improvement. At the same time, the responsibility for making final decisions and correcting errors remains with the student, which is consistent with the principles of academic integrity.

Thus, the use of artificial intelligence in the formation of self-learning and critical thinking skills contributes to the transition from passive assimilation of information to active cognitive activity. Methodically balanced application of AI allows creating conditions for the development of independence, analytical thinking and a responsible attitude to engineering decisions, which is a necessary component of the professional training of students in G3 and G7 specialties.

In order to practically specify approaches to the formation of self-study and critical thinking skills in students, it is advisable to generalize the possibilities of using software with elements of artificial intelligence in independent educational activities. The systematization of relevant educational tasks, actions of students and expected results allows us to clearly present the mechanisms of influence of digital tools on the development of analytical and reflective skills, which is presented in Table. 5.2.

The presented software examples demonstrate that the formation of self-study and critical thinking skills occurs not by receiving ready-made answers, but through the active interaction of students with tools for analysis, modeling and hypothesis testing. Artificial intelligence in this process plays the role of a catalyst for cognitive activity, while maintaining the leading role of independent work of students.

Table 5.2

Using software with AI elements to develop self-learning and critical thinking skills

Software/tool	Educational task of self-study	Actions of education seekers	How critical thinking is formed	Practical result
Language AI systems	Independent study of theoretical material	Formulating questions, clarifying concepts, comparing definitions	Analysis of the correctness of explanations, checking the logic of statements, asking clarifying questions	Conscious assimilation of theory, development of argumentation skills
Language AI systems	Analysis of alternative approaches to solving problems	Comparing different ways of solving, forming your own conclusion	Assessing the benefits and limitations of proposed solutions	Ability to make informed engineering choices
MATLAB	Independent research of engineering problems	Performing numerical experiments, analyzing results	Testing hypotheses by changing parameters and analyzing the consequences	Development of analytical thinking
Simulink	Independent study of system dynamics	Model building, transient analysis	Critically evaluate the correspondence of the model to the real process	Formation of a systemic vision
Python	Independent mastery of data processing and control algorithms	Implementation of own programs, testing of algorithms	Analysis of errors in the code, evaluation of the effectiveness of algorithms	Development of algorithmic thinking
Python + AI	Self-analysis of completed tasks	Checking program logic, interpreting results	Understanding the causes of errors and ways to eliminate them	Developing self-reflection skills

Table 5.2 shows practical scenarios for using language AI systems, as well as engineering software MATLAB, Simulink, and Python in the process of independent work of education seekers. The table systematizes educational tasks, typical types of activities of education seekers, and mechanisms for forming critical thinking skills, which allows revealing the role of digital tools in developing the ability to self-study.

The examples given demonstrate that the formation of critical thinking occurs through active analytical activity: asking questions, testing hypotheses, comparing alternative approaches, and reflecting on the results of one's own work. Language AI systems in this context are used to clarify concepts and analyze the logic of reasoning, while engineering software environments provide the possibility of experimental confirmation or refutation of engineering solutions.

Special attention in Table 5.2 is paid to the combination of programming and artificial intelligence tools, which allows students to independently analyze the effectiveness of algorithms, identify errors and evaluate the consequences of decisions. This approach contributes to the development of self-reflection skills and a responsible attitude to the results of their own activities, which is an important component of professional training in specialties G3 and G7.

5.3. USING ARTIFICIAL INTELLIGENCE FOR EXPLANATION AND SELF-VERIFICATION

The use of artificial intelligence to explain educational material and organize self-testing is an important element of independent work of education seekers in the process of obtaining technical education. For specialties G3 "Electrical Engineering" and G7 "Automation, Computer-Integrated Technologies and Robotics" such activity is of particular importance, since the educational material is characterized by a high level of abstraction, complex terminology and the need to understand the cause-and-effect relationships between theoretical provisions and practical results.

The essence of using artificial intelligence for explanation is to help students understand the content of the educational material, rather than simplifying it or replacing the teaching explanation. AI can be used to explain complex technical concepts step by step, interpret formulas, diagrams, control algorithms and modeling results. This approach allows students to return to the material at a time and pace convenient for them, which is especially important in conditions of independent work.

Using AI to explain technical material is appropriate in situations where a student has difficulty understanding the logic of engineering reasoning. For example, artificial intelligence tools can be used to explain the sequence of calculations, the logic of control algorithms, the reasons for changing system parameters, or the nature of transient processes. In this case, AI does not replace independent study of educational material, but acts as a means of supporting understanding.

No less important is the use of artificial intelligence to organize self-checking of the results of educational activities. Self-checking in technical disciplines involves not only checking the correctness of the final result, but also analyzing the logic of the task, the correctness of the assumptions made, and the correspondence of the results obtained to the physical essence of the processes. AI can be used to analyze calculations, models, or control programs in order to identify logical, parametric, or structural errors.

In the process of self-assessment, it is advisable to use AI as a feedback tool that provides the student with information about possible inaccuracies, contradictions, or weaknesses in the work. At the same time, the correction of errors and making final decisions remain with the student, which ensures

the preservation of the principles of academic integrity and independence of educational activity.

The use of artificial intelligence for explanation and self-testing is of particular importance in the education of foreign students. AI can be used to clarify technical terminology, explain complex formulations, and adapt explanations to the level of language preparation of students. This contributes to increasing the accessibility of educational material without reducing the requirements for learning outcomes.

Thus, the use of artificial intelligence for explanation and self-checking in the process of independent work creates conditions for conscious assimilation of educational material, development of analytical skills and formation of a responsible attitude towards the results of one's own educational activity. Methodically balanced application of AI allows to increase the efficiency of independent work of education seekers and ensures high-quality educational results in specialties G3 and G7.

To specify the possibilities of using artificial intelligence in the independent work of education seekers, it is advisable to systematize the main areas of its application for explaining educational material and organizing self-checking of the results of educational activities. Generalization of the relevant functions of AI, software, actions of education seekers and expected educational results allows us to clearly present the mechanisms of support for independent learning, which is presented in Table 5.3.

Table 5.3 systematizes the areas of use of software with elements of artificial intelligence in the independent work of education seekers, focusing on two interrelated aspects – explanation of educational material and organization of self-checking of the results of educational activities. The table summarizes the types of software, the educational purpose of the relevant tools, the characteristic actions of education seekers and the expected results of independent work.

The examples presented demonstrate that AI language systems are used primarily to explain theoretical concepts, interpret formulas, algorithms, and technical terminology, while engineering software environments MATLAB, Simulink, Python, and TIA Portal provide the ability to independently verify the correctness of calculations, models, and control algorithms. This division of functions contributes to a comprehensive approach to self-learning, in which explanation and self-testing complement each other.

Table 5.3 emphasizes that effective self-testing in technical disciplines involves analyzing not only the final result, but also the logic of task performance, the correctness of assumptions, and the correspondence of the results obtained to the physical essence of processes. The involvement of artificial intelligence in this context allows students to identify typical errors, analyze the causes of their occurrence, and reflect on their own learning activities.

Thus, Table 5.3 specifies the role of software with elements of artificial intelligence as a tool for analytical and explanatory support of independent work of education seekers, aimed at improving the quality of learning material and developing a responsible attitude towards the results of their own learning.

Table 5.3

Using software with AI elements for explanation and self-checking

Direction of use of AI	Software	Educational purpose	Actions of education seekers	The result of independent work
Explanation of theoretical provisions	Language AI systems	Explanation of concepts, formulas, technical terminology	Formulating questions, clarifying the content of concepts, checking understanding	Conscious assimilation of theoretical material
Explanation of calculation procedures	MATLAB, Python	Interpretation of calculation stages and results	Analysis of the sequence of calculations, verification of intermediate results	Developing self-control skills in engineering calculations
Explaining system dynamics	Simulink	Interpretation of transients and operating modes	Graph analysis, parameter changes, results explanation	Understanding the behavior of technical systems
Self-testing models	Simulink, MATLAB	Checking the correctness of models and settings	Model structure analysis, error detection	Improving modeling quality
Self-testing of control algorithms	TIA Portal	Analysis of control program logic	Checking the triggering conditions and command sequence	Understanding the logic of control algorithms
Reflection on learning outcomes	Language AI systems	Analysis of mistakes made and ways to eliminate them	Self-analysis of completed tasks	Development of reflective skills

5.4. METHODOLOGICAL RECOMMENDATIONS FOR INDIVIDUAL EDUCATIONAL TRAJECTORIES USING ARTIFICIAL INTELLIGENCE

Individual educational trajectories are an important component of the modern educational process in a higher education institution, especially in the context of training foreign students in the specialties G3 "Electrical Engineering" and G7 "Automation, Computer-Integrated Technologies and Robotics". They provide for taking into account individual educational needs, the level of previous training, the pace of learning the material and professional interests of students in order to increase the efficiency of education.

The essence of an individual educational trajectory is not to change educational standards or reduce the requirements for learning outcomes, but to flexibly organize educational activities, which allows students to achieve certain educational outcomes in different ways. In this context, artificial intelligence can be used as a tool to support the planning, monitoring and correction of individual educational activities.

One of the key areas of AI use is the diagnosis of individual educational needs. Based on the results of current monitoring, self-checking, and analysis of typical errors, AI can help students identify topics that require additional study and determine priority areas for independent work. This approach contributes to more conscious planning of educational activities.

Artificial intelligence can also be used for recommendatory support of an individual educational trajectory. Students can receive recommendations on the sequence of studying educational material, the selection of educational resources, software and typical practical tasks according to their own level of training. At the same time, these recommendations are of a recommendatory, not prescriptive nature, which preserves the autonomy of the student.

An important aspect is the use of AI to monitor progress within the individual educational trajectory. Analysis of the results of independent work, completed practical and laboratory tasks allows students to reflect on their own educational progress, assess the effectiveness of the chosen trajectory and, if necessary, adjust it. In this process, AI performs the function of analytical support, without replacing pedagogical support from the teacher.

The use of artificial intelligence tools has a particular methodological value for foreign students, as it allows them to adapt educational content to the level of language training, clarify technical terminology, and ensure an individual pace of material processing. This contributes to increasing the accessibility of technical education without simplifying its content.

At the same time, in the process of forming and implementing individual educational trajectories, it is necessary to strictly adhere to the principles of academic integrity. The use of artificial intelligence should be aimed at supporting planning, analysis and self-reflection, and not at performing educational tasks instead of the student. Responsibility for learning outcomes and making engineering decisions remains with the student.

Thus, the methodically justified use of artificial intelligence in organizing individual educational trajectories creates conditions for increasing the effectiveness of independent work, developing responsibility for one's own learning, and ensuring high-quality educational results in the process of obtaining technical education.

For the practical implementation of individual educational trajectories, it is advisable to systematize the possibilities of using artificial intelligence tools and relevant software, taking into account the educational needs of education seekers. Generalizing the relationship between the elements of an individual trajectory, digital tools and expected educational effects allows us to clearly present methodological approaches to personalizing the educational process, which is reflected in Table. 5.4.

Table 5.4 summarizes the main elements of the individual educational trajectory of education seekers and reflects the possibilities of using artificial intelligence tools and relevant software for their methodological support. The table systematizes the key stages of the formation and implementation of

Table 5.4

Implementing individual educational trajectories using AI and software

Individual trajectory element	AI tools	Software	Actions of education seekers	Educational effect
Educational needs assessment	Analytical AI tools	Language AI systems, LMS	Analysis of own results, identification of gaps	Awareness of individual needs
Planning independent work	Recommendation AI	Language AI systems, learning platforms	Formation of an individual training plan	Rational organization of study time
In-depth study of topics	Explanatory AI	MATLAB, Simulink	Independent analysis of models and processes	Deepening understanding of technical topics
Practical orientation of training	Analytical AI	TIA Portal, Python	Completion of individual practical tasks	Formation of applied engineering skills
Self-monitoring and trajectory correction	Reflexive AI	Language AI systems, Python	Self-analysis of results and correction of actions	Developing responsibility for learning

individual educational activities – from the diagnosis of educational needs to self-control and correction of the educational trajectory.

The examples above demonstrate that artificial intelligence tools can be used to analyze learning outcomes, provide recommendations, and provide feedback, while technical software provides practical implementation of individual learning tasks. The combination of AI language systems, learning management systems, and engineering software environments allows for the adaptation of learning content to the level of preparation and pace of learners without changing the intended learning outcomes.

Table 5.4 emphasizes that the individual educational trajectory is implemented not through simplification of educational material, but through flexible planning of independent work, selection of tools and phased analysis of results. This approach has a particular methodological value in teaching foreign students, as it allows taking into account linguistic and cognitive characteristics without reducing academic requirements.

Thus, Table 5.4 specifies the role of artificial intelligence and software as tools to support individual educational trajectories aimed at increasing the effectiveness of independent work, developing responsibility for one's own learning, and ensuring sustainable educational outcomes in the process of obtaining technical education.

CHAPTER 6. APPLICATION OF ARTIFICIAL INTELLIGENCE IN DESIGN AND RESEARCH WORK

6.1. COURSEWORK AND QUALIFICATION PAPERS: METHODOLOGY FOR USING AI

The use of artificial intelligence (AI) tools in the process of preparing course and qualification papers of education seekers must be carried out in compliance with the requirements of the current legislation of Ukraine in the field of education and the principles of academic integrity. In accordance with the Law of Ukraine "On Education" and the Law of Ukraine "On Higher Education", the education seeker bears personal responsibility for the content, results and conclusions of the work performed.

The methodology for using AI in coursework and qualification papers is based on the understanding of AI as an auxiliary tool used to support analytical, organizational, and editorial activities, but does not replace the student's independent educational and research work.

To systematize approaches to the use of AI at different stages of work, Table 6.1 provides a generalized description of the main areas of its application.

Analysis of the data presented in Table 6.1 shows that AI can be used at all stages of coursework or qualification work, but its role is limited to consulting and technical support. Making scientific decisions, formulating results and conclusions is exclusively the competence of the student.

An important aspect of the methodology is to define the limits of acceptable use of AI from the standpoint of academic integrity. According to Article 42 of the Law of Ukraine “On Education”, the use of third-party assistance without proper

Table 6.1

Application of artificial intelligence at the stages of coursework / qualification work

Stage of work execution	Student's tasks	AI functions	Expected result
Choosing a topic	Determining the direction of research	Clarifying the wording, narrowing the topic	Specific and relevant topic
Formulation of goals and objectives	Building the research logic	Checking the compliance of the goal and objectives	Agreed research structure
Structure planning	Developing the content of the work	Formation of structure options	Work plan
Source analysis	Literature review	Generalization, classification	Systematic review
Writing text	Formulation of copyright provisions	Linguistic and stylistic editing	Improved presentation quality
Forming conclusions	Interpretation of results	Logical check	Reasoned conclusions

indication may be considered a violation of the principles of academic integrity. Table 6.2 provides examples of acceptable and unacceptable use of AI tools.

Table 6.2

Examples of acceptable and unacceptable uses of AI

Scope of application	Permissible use	Unauthorized use
Formulation of the topic	Clarification of wording	Automatic theme creation
Goal setting	Checking logical consistency	Goal generation without author participation
Job tasks	Removing duplication	Substitution of author's tasks
Analysis of results	Logical check	Automatic conclusions

As can be seen from Table 6.2, the criterion for admissibility is the preservation of the author's responsibility for all scientific provisions of the work and the conscious use of the results obtained with the use of AI.

Special attention should be paid to the use of AI at the stage of preparing the text of the work. AI tools can be used for linguistic and stylistic editing, but not for creating the substantive parts of the study. A summary of the relevant limitations is given in Table 6.3.

Table 6.3

Limits of using AI when writing text

Type of activity	Allowed	Forbidden
Theoretical material	Language editing	Generating text without sources
Research results	Checking the logic of the presentation	Shaping results
Conclusions	Stylistic refinement	Creating meaningful conclusions

The use of AI is technical in nature and should not affect the scientific novelty and independence of the work.

Thus, the methodology for using artificial intelligence in course and qualification papers should be based on the principles of expediency, transparency, and academic integrity, which meets the requirements of the Ministry of Education and Science of Ukraine and contributes to improving the quality of educational and research training of students.

6.2. SEARCH, ANALYSIS AND SYSTEMATIZATION OF SCIENTIFIC AND TECHNICAL INFORMATION

Search, analysis and systematization of scientific and technical information is a mandatory stage of completing coursework and qualification papers. According to the requirements of the Ministry of Education and Science of Ukraine, the student must ensure the use of relevant, reliable and scientifically sound sources, as well as demonstrate the ability to critically analyze them.

Artificial intelligence tools can be used to increase the efficiency of working with large amounts of information, in particular when forming search queries, initial analysis of sources and their systematization. At the same time, AI is not an independent source of scientific information, but is used exclusively as an auxiliary tool.

The main areas of application of AI when working with scientific and technical information are given in Table 6.4.

Table 6.4

Using AI in searching and analyzing scientific and technical information

Stage of working with information	Student activity	AI functions	Result
Search for sources	Definition of key concepts	Forming search queries	Relevant list of sources
Material selection	Assessment of scientific value	Preliminary summary of the content	Selected sources
Information analysis	Comparison of approaches	Data structuring	Analytical generalizations
Systematization	Material classification	Grouping by attributes	Logically organized overview

The stages presented in Table 6.4 reflect a typical algorithm for working with scientific and technical information, in which AI performs the function of intellectual support, and all analytical decisions are made by the student.

An important component is the formation of correct search queries. AI can be used to select keywords in Ukrainian and foreign languages, as well as to refine terminology according to the subject area.

This is especially true when working with international scientometric databases.

– In the process of analyzing sources, it is advisable to use AI for:
– generalization of the content of articles;
– identifying common and different approaches;
– preliminary structuring of the material for further processing.
– However, the final analysis and critical evaluation of sources is a mandatory competency for the student. The limits of permissible use of AI at this stage are summarized in Table 6.5.

The data in Table 6.5 emphasize that AI cannot be used to form scientific conclusions or assess the significance of research results.

At the stage of information systematization, AI can be useful for creating tables, diagrams, lists of characteristics, and comparative reviews. This helps to increase the structure of the material and facilitates further use of the information when writing the theoretical section of the work.

At the same time, the student is obliged to:

– verify the accuracy of the information received;
– cite primary sources;
– adhere to the requirements of academic integrity.

Thus, the use of artificial intelligence in the search, analysis, and systematization of scientific and technical information meets the requirements of the

Table 6.5

Limits of using AI when analyzing scientific sources

Type of activity	Allowed	Forbidden
Literature review	Summary of content	Substitution of the author's analysis
Comparison of approaches	Structuring information	Forming conclusions
Data interpretation	Logical check	Assessment of scientific novelty

Ministry of Education and Science of Ukraine, provided that AI is used as a support tool, and not as a source of scientific knowledge or a replacement for the independent analytical activity of the student.

6.3. SUPPORT FOR ENGINEERING SOLUTIONS AND FEASIBILITY STUDIES

In the process of completing coursework and qualification works in engineering and applied fields, an important place is occupied by substantiating technical solutions and conducting a feasibility study. According to the requirements of the Ministry of Education and Science of Ukraine, a student must demonstrate the ability to independently analyze solution options, evaluate their effectiveness, and choose the optimal option with arguments.

Artificial intelligence tools can be used to support this process by processing input data, analyzing alternative options, and structuring calculation results. AI does not replace engineering thinking, but is used as an auxiliary tool to improve the quality of decisions made.

The main areas of use of AI in supporting engineering solutions are given in Table 6.6.

The information presented in Table 6.6 reflects a typical approach to the application of AI in engineering calculations, where the key condition is independent decision-making by the student.

When performing a feasibility study, AI can be used to analyze economic indicators, summarize calculated data, and prepare comparative tables. This allows you to reduce the time spent processing numerical information and focus on interpreting the results.

The main areas of application of AI in technical and economic calculations are given in Table 6.7.

Data obtained using AI should be checked for compliance with the initial conditions and calculation methods adopted in the relevant industry.

An important aspect is to define the limits of acceptable use of AI in engineering decision-making. A summary of such limits is given in Table 6.8.

The above restrictions ensure compliance with the principles of academic integrity and maintain the responsibility of the education seeker for the technical and economic decisions made.

Table 6.6

Using AI to justify engineering decisions

Stage of work	Student activity	AI functions	Result
Analysis of the technical task	Defining requirements and constraints	Generalization of conditions	Clearly formulated initial data
Consideration of alternatives	Formation of solution options	Comparison of characteristics	List of possible solutions
Preliminary calculations	Performing engineering assessments	Correctness check	Agreed calculation data
Performance evaluation	Parameter analysis	Structuring indicators	Informed choice

Table 6.7

Application of AI in feasibility studies

Indicator	Student activity	The role of AI	Expected result
Capital expenditure	Component analysis	Data generalization	Consolidated calculations
Operating costs	Cost estimation	Structuring	Comparison table
Payback period	Calculation of the indicator	Logic check	Correct results
Efficiency	Data interpretation	Visualization	Reasoned conclusions

Table 6.8

Limits of using AI in engineering and economic justification

Type of activity	Allowed	Forbidden
Engineering calculations	Formula and logic validation	Generating results without calculations
Choosing a solution option	Parameter analysis	Automatic selection
Economic assessment	Cost structuring	Forming conclusions
Justification	Data visualization	Substitution of authorial arguments

Thus, the use of artificial intelligence to support engineering decisions and feasibility studies in coursework and qualification papers is appropriate provided that AI is used as a tool for analyzing and organizing data, and not as a replacement for engineering thinking, professional responsibility, and independent analytical activity of the student.

6.4. FORMATION OF RESEARCH COMPETENCIES OF EDUCATION SEEKERS

The formation of research competencies is one of the key outcomes of the educational process in higher education institutions. According to the requirements of the Ministry of Education and Science of Ukraine and higher

education standards, a student must have the skills to analyze information, formulate research tasks, justify results, and present conclusions.

Artificial intelligence tools can be used as a means of supporting the development of these competencies, provided that they are used consciously and in a controlled manner. AI helps to increase the efficiency of educational and research activities, but does not replace the process of forming one's own scientific thinking.

The main areas of use of AI in the formation of research competencies are given in Table 6.9.

Table 6.9

Applying AI to build research competencies

Research competence	Student activity	The role of AI	Result
Analytical thinking	Problem analysis	Structuring information	Clear formulation of the problem
Working with sources	Literature review	Summary of materials	Systematic review
Research planning	Algorithm construction	Logic check	Agreed plan
Interpretation of results	Data analysis	Identifying patterns	Reasoned conclusions
Academic writing	Text preparation	Language editing	Qualitative presentation

The data in Table 6.9 demonstrate that AI is appropriate to use to support the analysis processes and organization of educational and research activities, with all key research decisions being made by the student.

An important role in the formation of research competencies is played by the development of the ability to critically evaluate the results obtained using digital tools. The student must be able to check the correctness of generalizations, the logic of reasoning, and the compliance of the results with the tasks set.

The limits of acceptable use of AI in the context of developing research competencies are summarized in Table 6.10.

Table 6.10

Limits of using AI in the formation of research competencies

Type of activity	Allowed	Forbidden
Statement of the problem	Analysis of formulations	Automatic problem detection
Hypothesis formation	Logical check	Generating hypotheses without justification
Analysis of results	Data structuring	Substitution of analytical activities
Conclusions	Stylistic refinement	Forming meaningful conclusions

The above restrictions ensure the preservation of the educational value of research activities and comply with the principles of academic integrity. The use of AI in educational and research activities also contributes to the development of self-control skills and self-assessment of work results. The student is given the opportunity to check the logic of his own reasoning, identify weaknesses in the argumentation and improve the quality of the presentation of research results.

Thus, the use of artificial intelligence tools in the formation of research competencies of education seekers is appropriate provided that the principles of academic integrity, transparency and the priority of independent cognitive activity are observed. This approach meets the requirements of the Ministry of Education and Science of Ukraine and contributes to the training of specialists capable of analytical, research and engineering activities in the conditions of digitalization of education.

CHAPTER 7. ACADEMIC INTEGRITY AND ETHICAL ASPECTS OF THE USE OF ARTIFICIAL INTELLIGENCE

7.1. REGULATORY AND LEGAL PRINCIPLES OF ACADEMIC INTEGRITY IN THE CONTEXT OF THE USE OF ARTIFICIAL INTELLIGENCE

Academic integrity in the modern system of education and science is a basic principle that ensures trust in the results of educational, scientific and scientific-technical activities. It combines the ethical norms of scientific culture and legal requirements enshrined in national legislation. In the context of the digitalization of education and the active use of artificial intelligence (AI), the issue of regulatory and legal support for academic integrity is gaining particular relevance, as new forms of creation, processing and presentation of the results of intellectual activity appear.

The main regulatory act that establishes the principles of academic integrity in Ukraine is the Law of Ukraine "On Education" (2017). According to Article 42 of this Law, academic integrity is defined as a set of ethical principles and legally established rules that must be observed by participants in the educational process during study, teaching and conducting scientific activities. The Law explicitly states that adherence to academic integrity is the responsibility of both students and pedagogical and scientific-pedagogical workers.

The provisions of Article 42 of the Law of Ukraine "On Education" also define a list of typical violations of academic integrity, including academic plagiarism, fabrication and falsification of results, cheating, deception, bribery, and biased evaluation. It is important to emphasize that the legislator does not limit these violations to specific technologies or tools. This means that the use of artificial intelligence in itself is not a violation, but it becomes such if it leads to non-compliance with the principles of independence, honesty, or transparency.

An example from educational practice:

- *A student can use AI to select general definitions or language edit a text. However, if AI creates the entire content of a coursework and presents the result as its own intellectual product, this is considered a violation of the principle of autonomy and misleading the teacher.*

Further development of regulatory and legal regulation took place with the adoption of the Law of Ukraine "On Academic Integrity" (2025), which significantly detailed and expanded the legal mechanisms for ensuring integrity. This Law applies to all levels of education and scientific activity and, for the first time at the legislative level, clearly regulates the issue of using results generated by computer programs, including artificial intelligence.

According to the provisions of the Law of Ukraine "On Academic Integrity", results created using software tools are not recognized as copyrighted if the fact of their use has not been indicated. Thus, the legislation introduces a mandatory requirement for transparency and declaration of the use of AI in educational and scientific activities.

An example from scientific practice:

- *If a researcher uses AI to generate fragments of a scientific article or formulate conclusions and does not note this in the methodological section or notes, such a publication may be considered dishonest, and its author may be held academically liable.*

To systematize the normative principles of academic integrity and define the limits of permissible use of AI, it is advisable to summarize the relevant provisions in Table 7.1.

Of responsibility of subjects of the educational process requires special attention. The Law of Ukraine "On Academic Integrity" introduces the concept of institutional responsibility, according to which educational institutions are obliged to create internal systems for ensuring academic integrity, develop policies for the use of AI, and determine procedures for responding to violations and applying sanctions (see Table 7.2).

Table 7.1

Principles of academic integrity and their implementation when using AI

Principle	Normative content	Acceptable practices	Violation
Independence	Personal intellectual contribution	Help with structure, language editing	Full generation of work
Honesty	A true representation of the process	Declaring the use of AI	Hiding tools
Respect for authorship	Copyright compliance	Checking sources	Attribution of results
Objectivity	Reliability of results	Fact checking	Using fictional data
Responsibility	Personal responsibility	Final text control	Translating errors into AI

Table 7.2

Levels of responsibility in the field of academic integrity when using AI

Subject	Content of responsibility	Typical risks
Education seeker	Independence and reliability of results	Replacing your own work with AI
Teacher	Control and methodological clarifications	Formal approach
Educational institution	Policies and procedures	Lack of regulations
State	Regulatory support	Insufficient control

Thus, the regulatory framework for academic integrity in Ukraine forms a comprehensive regulatory system that allows for the integration of artificial intelligence into the educational and scientific process without violating ethical and legal standards. The Law of Ukraine "On Education" and the Law of Ukraine "On Academic Integrity" clearly state that AI can only be used as an auxiliary tool, and responsibility for the results of educational and scientific activities always lies with a person.

7.2. RISKS OF UNETHICAL USE OF ARTIFICIAL INTELLIGENCE IN THE EDUCATIONAL PROCESS

The active introduction of artificial intelligence into the educational process significantly transforms approaches to learning, assessment and organization of independent work of students. At the same time, the use of AI generates a number of ethical, legal and pedagogical risks, which, without proper regulation, can lead to systemic violations of academic integrity. Unlike traditional forms of dishonest behavior (cheating, direct plagiarism), the risks associated with AI are often hidden, which makes their detection and assessment difficult.

One of the key risks is the replacement of personal intellectual activity with results generated by algorithms. In this case, the student formally performs the task, but does not actually demonstrate his own knowledge, skills and abilities. This contradicts the very purpose of education as a process of forming competencies, and not only obtaining a formal result in the form of an assessment or a test.

Example:

- *During the essay, the student uses AI to generate arguments, examples, and conclusions. The text has a logical structure and academic style, but the student is unable to explain the concepts used during an oral discussion. In such a situation, the result of the work does not reflect the real level of preparation of the student.*

For a thorough analysis, it is advisable to systematize the risks of unethical use of AI by main areas covering the educational process, the legal sphere, and the institutional level (see 7.3).

Table 7.3

Main risk groups of unethical use of AI in education

Risk group	Characteristic
Educational and pedagogical	Loss of independence, decreased motivation to learn
Ethical	Violation of the principles of honesty and responsibility
Legal	Failure to comply with the requirements of academic integrity legislation
Institutional	Weakening of the education quality assessment and control system

1. Educational and pedagogical risks. These risks are related to the fact that AI can be used as a replacement for the thinking process, rather than as an auxiliary tool. This leads to the formation of superficial knowledge and a decrease in the level of critical thinking.

Example:

- *A student systematically uses AI to solve practical problems in economics or programming. As a result, he gets the correct answers, but does not master the algorithm for solving the problem and is unable to complete a similar task without the help of AI.*

This approach creates the illusion of learning success, while undermining the quality of the educational outcome. From a pedagogical point of view, this means the degradation of the educational function of assessment, when the assessment ceases to reflect the real level of formed competencies.

2. Ethical risks and violation of the principle of responsibility. The second group consists of ethical risks associated with the erosion of personal responsibility for the result of the work. In the case of using AI, the student may believe that the responsibility for errors, inaccuracies or unreliable information lies with the program, and not with him personally.

Example:

- *In a term paper, a student uses AI-generated statistical data without checking its validity. After identifying errors, the student explains it as an "algorithm error," effectively avoiding responsibility for the result.*

Such a position contradicts the principle of academic integrity, according to which a person is the sole subject of responsibility for the submitted work, regardless of the tools used.

3. Legal risks and compliance. Legal risks arise when AI practices do not comply with the requirements of academic integrity legislation. Legislation clearly states that the results of educational and scientific activities must be independent and the sources of their creation must be transparent.

Example:

- *When writing a scientific article, the author uses AI to generate a literature review, but does not check the generated references. Some of the sources turn out to be fictitious, which creates grounds for recognizing the work as dishonest and withdrawing it.*

In order to specify legal and ethical risks, it is advisable to compare typical violations with their possible consequences (see Table 7.4).

4. Institutional risks for educational institutions. A separate group is institutional risks that arise in the absence of clear rules for the use of AI at the level of an educational institution. Under such conditions, teachers apply

Table 7.4

Typical violations when using AI and their consequences

Type of violation	The essence of the violation	Possible consequences
Hidden use of AI	Lack of declaration	Academic responsibility
Authorship substitution	Assigning generated text	Canceling results
Using fictional data	Unverified information	Loss of trust, sanctions
Dependent execution	Complete dependence on AI	Reassessment or deduction

different approaches to assessment, and students receive conflicting signals regarding the admissibility of the use of AI.

Example:

- *In one department, the use of AI is allowed without restrictions, in another it is completely prohibited. This creates unequal conditions for learning and undermines the principle of fair assessment (see Table 7.5).*

Table 7.5

Institutional risks and ways to minimize them

Risk	Reason	The path to minimization
Inequality of requirements	Lack of a unified policy	Development of internal regulations
Formal control	Insufficient teacher training	Methodological recommendations
Mass violations	Lack of sanctions	Clear accountability procedures

Thus, the risks of unethical use of artificial intelligence in the educational process are complex and cover the educational, ethical, legal and institutional levels. Their emergence is due not to the technology itself, but to the lack of clear rules, proper control and a culture of responsible use of AI. Awareness and systematization of these risks is a necessary prerequisite for the development of effective mechanisms for preventing violations of academic integrity.

7.3. DEVELOPING A RESPONSIBLE ATTITUDE TOWARDS THE RESULTS OBTAINED FROM ARTIFICIAL INTELLIGENCE

The formation of a responsible attitude towards the results obtained using artificial intelligence is one of the key tasks of the modern educational process. Unlike traditional learning tools, AI is able to generate texts, ideas, examples and even analytical generalizations, which creates the risk of perceiving the obtained result as automatically correct and complete. In such a context, responsibility for the educational or scientific result may gradually devalue, which contradicts the principles of academic integrity.

A responsible attitude implies the awareness that any result created using AI is auxiliary, not self-sufficient. The ultimate responsibility for the content, reliability and correctness of the submitted material lies with the person - the education seeker or scientific and pedagogical worker. This provision is fundamental from both an ethical and legal point of view.

The first step in developing a responsible attitude is to have a clear understanding of the role of artificial intelligence in educational activities. AI is not a subject of learning or scientific activity and cannot act as the author of educational or scientific results. Its function is to support the educational process, in particular:

– searching for ideas;
– structuring the material;
– language editing;
– modeling examples.

Example:

- *The student uses AI to create a coursework plan and preliminary formulation of the problem. Later, he independently selects sources, analyzes them and forms conclusions. In this case, AI performs an auxiliary function, without replacing the student's intellectual activity.*

Instead, the complete generation of text with its subsequent presentation as one's own result indicates a lack of responsible attitude towards the learning process and results.

The second important aspect of responsible use of AI is a critical attitude towards the generated information. Artificial intelligence algorithms work on the basis of statistical models and do not guarantee absolute accuracy, relevance or completeness of data. Therefore, the results obtained with the help of AI require mandatory verification.

Example:

- *When preparing an abstract, AI suggests a definition of a term or a description of a regulatory document. The student should check this data against official sources, as even a minor inaccuracy can lead to a distortion of the content of the work (see Table 7.6).*

Table 7.6

Common mistakes in non-critical use of AI

Error type	The essence of the problem	Consequences
Factual inaccuracies	Outdated or incorrect information	Wrong conclusions
Fictional sources	Non-existent links	Integrity violation
Generalization without analysis	Superficial content	Decrease in work quality
Logical contradictions	Incorrect arguments	Loss of scientific value

Taking responsibility for the results obtained from AI is inextricably linked to the principle of transparency. Declaring the fact of using AI avoids misleading the teacher or reviewer about the extent of the author's personal contribution.

In modern educational practice, transparency can be implemented through:

– notes in the text of the work;
– explanations in the methodological section;
– oral defense explaining the role of AI.

Example:

- *In the explanatory note to the project, the student notes that AI was used for language editing and generating preliminary wording options, but all analytical conclusions were made independently.*

Table 7.7

Forms of declaration of the use of AI in educational work

Form	Description	Transparency level
Note in the work	Brief description of the tools	Average
Methodological description	Detailing the role of AI	High
Oral protection	Explanation of the work process	Very high

A key element of a responsible attitude is the realization that no digital tool removes responsibility from a person. The student is responsible for the reliability of facts, the correctness of references, the logic of argumentation, and the overall quality of the work.

Example:

- *If incorrect statistical data is found in a thesis, an explanation such as "AI generated it" cannot be accepted as an excuse, since the author of the thesis is responsible for the final result (see Table 7.8).*

Table 7.8

Components of Responsible AI Outcomes

Component	Content
Awareness	Understanding the role of AI
Criticality	Information verification
Transparency	Declaring use
Responsibility	Accepting the consequences

Thus, the formation of a responsible attitude towards the results obtained using artificial intelligence is a necessary condition for maintaining academic integrity in modern education. AI can significantly increase the efficiency of the educational process, but only if it is used consciously, transparently and critically. Responsibility for the educational and scientific result always remains with the person, not the algorithm.

7.4. THE ROLE OF THE TEACHER IN MONITORING AND REGULATING THE USE OF ARTIFICIAL INTELLIGENCE

In the context of the active introduction of artificial intelligence into the educational process, the role of the teacher is significantly transformed. If earlier the main emphasis was on the transfer of knowledge and verification of learning outcomes, today the teacher acts not only as a source of knowledge, but also as a regulator of the ethical and normative boundaries of the use of digital technologies. It is the position of the teacher that largely determines whether AI will become a tool for improving the quality of education or a factor in the spread of academic dishonesty.

Control and regulation of the use of AI by the teacher is based on the requirements of legislation on academic integrity, internal regulatory documents of the educational institution, and pedagogical responsibility for the learning outcomes of students.

1. Establishing clear rules for the use of AI in an academic discipline. The first and basic task of a teacher is to determine the permissible and unacceptable forms of using AI within a specific academic discipline. The absence of clear rules creates a situation of normative uncertainty in which students independently interpret the boundaries of what is permissible, which leads to massive violations of academic integrity.

Rules can be fixed:

– in the discipline syllabus;
– in methodological recommendations for the performance of work;
– in explanations before completing control or final tasks.

Example:

- *The teacher allows the use of AI for language editing of texts and searching for ideas, but prohibits the use of AI for forming analytical conclusions. In this case, the student clearly understands the limits of what is permissible and cannot refer to "ignorance" in case of violation.*

2. Creating an ethical educational environment. The role of the teacher is not limited to control and sanctions. An important component is the formation of a culture of academic integrity, in which ethical behavior is perceived as the norm, and not as external coercion. This involves systematic clarification of the principles of academic integrity and the consequences of their violation.

Example:

- *At the beginning of the semester, the instructor conducts a separate class dedicated to academic integrity and responsible use of AI, explaining not only the prohibitions but also the logic behind these requirements.*

This approach promotes conscious compliance with the rules and reduces the number of violations associated with misunderstanding or a formal attitude to the requirements (see Table 7.9).

Table 7.9

The main areas of activity of the teacher regarding the regulation of the use of AI

Direction	Activity content
Normative	Defining rules and restrictions
Educational	Clarifying the principles of integrity
Control	Checking the independence of work
Educational	Formation of a responsible attitude

3. Control of the independence of the implementation of educational work. Control of independence is one of the most difficult aspects of the teacher's work in the conditions of using AI. Traditional methods of verification, in particular the detection of text borrowings, are not always effective in relation to generated materials. Therefore, the role ***of complex forms of assessment is increasing,*** which allow checking the real level of assimilation of the material.

Such forms include:

– oral defense of written works;
– phased completion of tasks;
– analysis of drafts and interim results;
– individual interviews.

Example:

- *After submitting the coursework, the instructor conducts a brief oral interview on the key points of the work. The student's inability to explain his or her own conclusions is a reason to doubt the independence of the task.*

4. Regulation and response to violations. The teacher also plays an important role in identifying and responding to violations of academic integrity related to the use of AI. The response should not be selective, but systematic and in accordance with the established procedures of the educational institution.

It is important to maintain a balance between:

– the principle of inevitability of responsibility;
– the principle of fairness and proportionality of sanctions.

Example:

- *In the event of a first violation involving undeclared use of AI, the student may be asked to retake the assignment. Systematic or egregious violations may result in more severe academic sanctions.*

Table 7.10

Forms of control and regulation of the use of AI by the teacher

Form	Characteristic	Advantages
Oral protection	Checking for understanding	High efficiency
Step-by-step tasks	Process control	Preventing substitution

Continuation of Table 7.10

Form	Characteristic	Advantages
Methodological guidelines	Clear rules	Risk reduction
Consultations	Explanation of requirements	Building trust

5. Professional responsibility of the teacher. It is necessary to emphasize the professional responsibility of the teacher himself. A formal approach to control, ignoring obvious signs of dishonesty or the absence of clear requirements actually contribute to the spread of unethical practices. Therefore, the teacher is responsible not only for assessment, but also for the quality of the educational environment that he forms.

Example:

- *If a teacher accepts work that clearly does not meet the level of students' preparation without additional verification, this reduces trust in the assessment and demotivates honest students.*

Thus, the role of the teacher in controlling and regulating the use of artificial intelligence is complex and multidimensional. It includes establishing clear rules, creating a culture of academic integrity, applying effective forms of control and responding fairly to violations. It is the teacher who acts as a key link between regulatory requirements and real educational practice, ensuring the ethical and responsible use of AI in the educational process.

CONCLUSIONS

Methodological recommendations are dedicated to the current problem of using artificial intelligence in the educational process, taking into account the requirements of academic integrity, ethical norms and the current regulatory and legal framework. The relevance of the topic is due to the rapid development of digital technologies and their active penetration into the sphere of education, which requires not only technical, but primarily pedagogical, methodological and ethical understanding.

In the course of preparing the recommendations, theoretical, normative and practical aspects of the use of artificial intelligence in educational activities were systematized. It was found that AI is a powerful tool to support the educational process, which, if methodically balanced in its implementation, is capable of increasing the effectiveness of learning, contributing to the individualization of educational trajectories, the development of analytical skills and skills in working with information. At the same time, it was proven that uncontrolled or unconscious use of AI creates significant risks for the quality of education and compliance with the principles of academic integrity.

The methodological recommendations summarize the regulatory and legal principles governing academic integrity in Ukraine, which form the mandatory framework for the use of artificial intelligence in the educational process. It is shown that the current legislation does not deny the use of digital tools, but clearly establishes requirements for the independence of task performance, transparency of the author's contribution and personal responsibility for the results of educational and scientific activities. Thus, artificial intelligence within the educational process should be considered exclusively as an auxiliary tool, and not as a replacement for human intellectual activity.

Particular attention is paid in the recommendations to the analysis of the risks of unethical use of AI. It has been established that these risks are multi-level in nature and cover educational and pedagogical, ethical, legal and institutional dimensions. The most dangerous among them are the replacement of personal thinking with automated results, reduced motivation for independent work, the formation of dependence on algorithmic solutions, as well as the erosion of personal responsibility for the reliability and quality of educational results. Awareness of these risks is a necessary prerequisite for the development of effective mechanisms for their minimization.

The methodological recommendations emphasize the importance of forming a responsible attitude towards the results obtained using artificial intelligence. It is emphasized that the key components of such an attitude are a critical assessment of the generated information, mandatory verification of facts and sources, transparent declaration of the role of digital tools and awareness of personal responsibility for the final result. The formation of these

approaches should become a systemic component of the educational process, and not a one-time element of control.

An important place in the methodological recommendations is given to the role of the teacher as a key subject of regulation of the use of artificial intelligence in education. It is summarized that the effective activity of the teacher in this context involves a combination of regulatory regulation, methodological support, pedagogical control and educational influence. It is the teacher who ensures a balance between the use of innovative technologies and the preservation of academic values, forms a virtuous educational environment and promotes the conscious use of AI by students.

The practical value of the methodological publication lies in the possibility of its use by teachers, students, and administration of educational institutions to develop internal policies, methodological recommendations, and educational materials on the responsible use of artificial intelligence. The proposed approaches can be adapted to different levels of education and the specifics of academic disciplines.

The prospects for further development of the raised issues are associated with the need for constant updating of methodological approaches in response to the evolution of artificial intelligence technologies. Further research is required on the issues of improving systems for assessing educational outcomes in the context of digitalization, developing effective models for integrating AI into educational programs, and forming digital and ethical competence of participants in the educational process. Ensuring a sustainable combination of innovation and academic integrity remains a key challenge and at the same time a strategic objective of modern education.

LIST OF SOURCES USED:

1. Anderson T. The Theory and Practice of Online Learning. 2nd ed. Edmonton: AU Press, 2008.
2. Baker RS, Inventado PS Educational data mining and learning analytics. In: Learning Analytics. New York: Springer, 2014.
3. Holmes W., Bialik M., Fadel C. Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Boston : Center for Curriculum Redesign, 2019.
4. Luckin R., Holmes W., Griffiths M., Forcier L. Intelligence Unleashed: An Argument for AI in Education. London: Pearson, 2016.
5. Selwyn N. Should Robots Replace Teachers? AI and the Future of Education. Cambridge : Polity Press, 2019.
6. Williamson B. Big Data in Education. London: SAGE, 2017.
7. Floridi L. Ethics of Artificial Intelligence. Oxford : Oxford University Press, 2023.
8. Zawacki-Richter O. et al. Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education.* 2019.
9. Russell S., Norvig P. Artificial Intelligence: A Modern Approach. 4th ed. London : Pearson, 2021.
10. Tegmark M. Life 3.0: Being Human in the Age of Artificial Intelligence. New York: Knopf, 2017.
11. Constitution of Ukraine: Law of Ukraine dated 28.06.1996 No. 254k/96-VR.
12. On education: Law of Ukraine dated 05.09.2017 No. 2145-VIII.
13. On Higher Education: Law of Ukraine dated 01.07.2014 No. 1556-VII.
14. On professional pre-higher education: Law of Ukraine dated 06.06.2019 No. 2745-VIII.
15. On scientific and scientific-technical activities: Law of Ukraine dated 26.11.2015 No. 848-VIII.
16. On copyright and related rights: Law of Ukraine dated 23.12.1993 No. 3792-XII.
17. About information: Law of Ukraine dated 02.10.1992 No. 2657-XII.
18. On the protection of personal data: Law of Ukraine dated 01.06.2010 No. 2297-VI.
19. Procedure for awarding the degree of Doctor of Philosophy: Resolution of the Cabinet of Ministers of Ukraine dated January 12, 2022 No. 44.
20. Procedure for awarding the degree of Doctor of Sciences: Resolution of the Cabinet of Ministers of Ukraine dated November 17, 2021 No. 1197.
21. Code of Ethics of a Scientist of Ukraine: approved by the General Meeting of the NAS of Ukraine on April 15, 2009.
22. Recommendations for developing a system for ensuring academic integrity in higher education institutions. Kyiv: NAZYAVO, 2019.
23. Recommendations of the Ethics Committee of the National Academy of Sciences of Ukraine on limiting the use of sources of the aggressor state. Kyiv, 2022.

24. European Code of Conduct for Research Integrity. Revised ed. Berlin: ALLEA, 2023.
25. Singapore Statement on Research Integrity. Singapore, 2010.
26. Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations. Montreal, 2013.
27. Amsterdam Agenda on Research Integrity. Amsterdam, 2017.
28. Hong Kong Principles for Assessing Researchers. Hong Kong, 2019.
29. Cape Town Statement on Fostering Research Integrity through Fair Partnerships. Cape Town, 2022.
30. The Fundamental Values of Academic Integrity. 3rd ed. Clemson : ICAI, 2021.
31. Recommendation on Science and Scientific Researchers. Paris: UNESCO, 2017.
32. Recommendation on the Ethics of Artificial Intelligence. Paris: UNESCO, 2021.
33. Guidance for Generative AI in Education and Research. Paris: UNESCO, 2023.
34. Ethics Guidelines for Trustworthy AI. Brussels : European Commission, 2019.
35. Artificial Intelligence Act (AI Act). Brussels: European Union, 2024.
36. Artificial Intelligence in Education: Challenges and Opportunities. Paris: OECD, 2021.
37. DSTU 8302:2015. Information and documentation. Bibliographic reference.
38. DSTU 3008:2015. Reports in the field of science and technology.
39. European Framework for the Digital Competence of Educators (DigCompEdu). Luxembourg, 2017.
40. World Economic Forum. Shaping the Future of Learning. Geneva, 2020.
41. Stanford University. AI Index Report. Stanford, 2023.
42. EDUCAUSE. AI in Higher Education. 2022.
43. IEEE. Ethically Aligned Design. 2022.
44. World Bank. Education and Technology Overview. 2020.
45. OpenAI. ChatGPT: official web resource. URL: https://chat.openai.com
46. OpenAI. GPT-4 Technical Report: official web resource. URL: https://openai.com
47. Google. Gemini AI: official web resource. URL: https://ai.google
48. Microsoft. Copilot: official web resource. URL: https://copilot.microsoft.com
49. Anthropic. Claude AI: official web resource. URL: https://www.anthropic.com
50. Turnitin. AI Writing Detection: official web resource. URL: https://turnitin.com
51. Grammarly. AI Writing Assistant: official web resource. URL: https://www.grammarly.com
52. QuillBot. AI Paraphrasing Tool: official web resource. URL: https://quillbot.com
53. Perplexity AI: official web resource. URL: https://www.perplexity.ai
54. Coursera. Artificial Intelligence in Education Courses: official web resource. URL: https://www.coursera.org
55. edX. AI and Ethics Courses: official web resource. URL: https://www.edx.org
56. McKinsey Global Institute. The Future of Work. 2017.
57. Pearson. AI and the Future of Learning. 2020.
58. Brookings Institution. AI and Education Policy. 2021.
59. MIT Open Learning. Artificial Intelligence and Education Resources.
60. Harvard University. Teaching and Learning with AI.

ANNEX'S

ANNEX 1

EXAMPLES OF TASKS USING AI

1. Tasks for explaining and mastering theoretical material

Goal: to facilitate the understanding of complex technical concepts and physical processes by foreign students.

Educational and technical task: the student receives an explanation of the principle of operation of an electromechanical system (asynchronous electric motor, servo drive, automatic control system) using AI. After that, the student is obliged to:

– check the correctness of the explanation using educational sources;
– submit your own formulation of the working principle;
– explain the influence of basic parameters (voltage, frequency, load);
– give an example of the use of the system in automated production.

The role of AI: explanatory, reference.

Result: conscious assimilation of theoretical provisions.

2. Tasks for structuring educational material

Goal: to develop logical thinking skills and systematization of knowledge.

Educational and technical task: the student uses AI to form a preliminary plan for the topic in the disciplines "Electronics and Microcircuit Engineering" "Theory of Automatic Control", "Electric machines".

Next, the student:

– adapts the plan to the work program of the discipline;
– clarifies the sequence of studying the material;
– argues for the proposed structure.

The role of AI: forming a draft plan.

Result: skills in structural analysis of technical material are developed.

3. Technical task for the analysis of the electric drive

Discipline: Electrical Machines

Goal: to develop skills in analyzing technical characteristics.

Technical task: using AI to generate a list of the main technical parameters of the electric drive (rated power, torque, efficiency, operating mode). After that, the student:

– analyzes parameters independently;
– determines permissible operating modes;
– draws a conclusion on the feasibility of using the drive in an automated system.

The role of AI: reference.

Result: ability to analyze and interpret technical specifications.

4. Technical task for the development of a control algorithm

Discipline: Automatic Control Theory

Goal: development of algorithmic thinking.

Technical task: the student receives an example of an electromechanical system control algorithm (start - work - stop) using AI.

Next, the student:

– analyzes the logic of the algorithm;
– complements it with emergency modes;
– presents the final version in the form of a flowchart;
– explains the decisions made.

AI role: auxiliary (example of structure).

Result: skills in developing control algorithms are formed.

5. Tasks for selecting sensors and actuators

Discipline: Electronics and microcircuitry

Goal: to develop project competencies.

Technical task: using AI to obtain a list of sensors used in automation systems. Next, the student:

– classifies sensors by operating principle;
– selects a sensor for a specific control system;
– justifies the choice taking into account technical parameters.

The role of AI: informational.

Result: the ability to select elements of automated systems.

6. Technical task for diagnostics of electromechanical systems

Discipline: Construction, debugging and maintenance of automation devices

Goal: develop technical analysis skills.

Technical task: the educational provider uses AI to generate a list of possible faults in the electric drive. After that, the student:

– determines the causes of malfunctions;
– suggests methods for their elimination;
– assesses the impact of faults on the safety and reliability of the system.

The role of AI: reference.

Result: technical diagnostic skills developed.

7. Tasks for reflection and monitoring of academic integrity

Goal: To form a responsible attitude towards the use of AI.

Task content: After completing any of the above tasks, the student submits a written explanation stating:

– at what stage was AI used;
– what results were obtained with its help;
– what decisions are made independently.

ANNEX 2

RECOMMENDED ARTIFICIAL INTELLIGENCE TOOLS FOR ELECTROMECHANICS, AUTOMATION AND PLC PROGRAMMING

Table D. 2.1

Universal AI tools for educational support

Tool name	Application area	Functional purpose	Methodological feasibility of use	Limitation
ChatGPT (OpenAI)	Electromechanics, automation	Explanation of the principles of system operation, analysis of algorithms	Explanation of theory, language support for foreign students	Full report generation is prohibited
Microsoft Copilot	Technical documentation	Analysis of texts, standards, instructions	Working with equipment passports	Not used for technical solutions
Grammarly	Technical texts	Language and stylistic correction	Preparation of reports in English	Does not affect the content

Table D. 2.2

AI tools for PLC programming and training

Tool name	PLC / environment	Supported languages	Educational purpose	The role of AI
GitHub Copilot	PLC / ST	Structured Text	Syntax hints, logic	Auxiliary
Siemens TIA Portal	Siemens PLC	LAD, FBD, ST	Design and simulation	Analytical
CODESYS	IEC 61131-3	LAD, FBD, ST, IL	Universal PLC training	Educational
Automation Studio	PLC / electric drive	FBD, ST	Control modeling	Auxiliary

Table D. 2.3

Tools for modeling electromechanical systems

Tool name	Type of systems	Main features	Educational application	Training level
MATLAB / Simulink	Electric drive	Modeling, dynamics analysis	Laboratory and coursework	Medium–high
ANSYS Motor-CAD	Electric motors	Analysis of electromagnetic processes	Project work	High
PSCAD	Electric power industry	Transient process modeling	Analysis of operating modes	High

Table D. 2.4

Tools for analyzing technical information and diagrams

Tool	Material type	Appointment	Methodical effect
ChatGPT	Schemes, algorithms	Explanation of the logic of work	Increasing understanding
Copilot	Technical descriptions	Analysis of standards and requirements	Learning optimization
PDF AI Readers	Technical documentation	Finding and explaining fragments	Working with manuals

Table D. 2.5

Tools for monitoring academic integrity

Tool	Control object	Function	Methodological purpose
Turnitin	Report texts	AI generation detection	Independence control
Plagiarism Checker X	Text works	Borrowings search	Ensuring integrity

Table D. 2.6

Recommended tool alignment by discipline

Discipline	Recommended tools
Electromechanics	ChatGPT, MATLAB, ANSYS
Electric drive	Simulink, CODESYS
Automatics	TIA Portal, CODESYS
PLC programming	GitHub Copilot, TIA Portal
Systems operation	ChatGPT, Copilot

Table D. 2.7

Criteria for evaluating the performance of PLC tasks (LAD, FBD, Structured Text languages)

Evaluation criterion	Indicator description	Maximum score
Algorithm correctness	The control logic corresponds to the technical specifications	25
Program functionality	The program runs without errors in the simulation	20
Handling emergency modes	Protection and emergency conditions are provided	15
Optimality of the solution	Rationality of code structure	15
Comments and design	Availability of explanations, clear names	10
Independence of execution	Correct declaration of the use of AI	15
Total		**100**

Table D. 2.8

Relevance of artificial intelligence tools expected learning outcomes

AI tool	Educational outcome	Formed competence
ChatGPT	Understanding PLC principles	Analytical thinking
GitHub Copilot	Learning ST syntax	Algorithmic skills
TIA Portal	Implementation of algorithms	Project competence
CODESYS	Universal PLC thinking	Professional skills
MATLAB / Simulink	System dynamics analysis	Engineering analysis
Turnitin	Awareness of integrity	Academic culture

Table D. 2.9

Sample declaration of use of AI when performing technical and PLC tasks

Parameter	Information filled in by the student
Last name, first name	
Group, specialty	
Discipline	
Task name	
AI tool(s)	
Stage of using AI	Explanation / analysis / verification
Result obtained	Short description
Independently completed	What has been done without AI
Student signature	
Date	

Table D. 2.10

Logic model "Scenario → Task → Evaluation"

Educational scenario	Educational/ technical assignment	AI tool	The role of AI	Control form	Main evaluation criteria
Studying the principle of operation of an electric motor	Explain the principle of operation of an induction motor and describe the effect of load	ChatGPT	Explana-tory	Oral interview, written pre-sentation	Correctness of explanation, independent conclusions
Electric drive analysis	Analyze the technical characteristics of the electric drive	ChatGPT, Copilot	Refe-rence	Parameter table	Accuracy of analysis, validity of conclusions
PLC control algorithm	Develop a control algorithm (start-stop-crash)	ChatGPT, Copilot	Chernet-kova	Algorithm protection	Logic, complete-ness, emergen-cy modes

Continuation of Table D. 2.10

Educational scenario	Educational/ technical assignment	AI tool	The role of AI	Control form	Main evaluation criteria
Sensor selection	Select sensors for the control system and justify the choice	ChatGPT	Informa-tional	Written justification	Correctness of choice, technical reasoning
Fault diagnosis	Identify the causes of electric drive malfunctions	ChatGPT	Refe-rence	Case analysis	Depth of analysis, correctness of decisions
Reflection and virtue	Fill out the AI usage declaration	–	Declara-tion	Declaration verification	Transparency, responsibility

Table D. 2.11

Correspondence of scenarios to learning outcomes and competencies

Scenario	Expected learning outcome	Formed competence
Theoretical	Understanding physical processes	Professional
Analytical	Analysis of technical parameters	Engineering and analytical
Algorithmic	Development of PLC algorithms	Algorithmic
Project	Reasoned selection of elements	Project
Practical	Systems diagnostics	Professional
Reflexive	Conscious use of AI	Academic integrity

Table D. 2.12

Integrated assessment criteria within the model

Criteria group	Evaluation indicators	Maximum score
Technical correctness	Relevance to the task, accuracy	30
Algorithmic logic	Sequence, emergency modes	20
Analytics	Reasonableness of decisions	20
Design	Structure, comments	10
Independence	Correct use of AI	20
Together		**100**

Table D. 2.13

Sequence of implementation of the logic model in the educational process

Stage	Teacher action	Student action	Result
1	Formulates a scenario	Familiarizes with the topic	Understanding goals
2	Gives tasks	Performs with AI	Draft decision
3	Advises	Analyzes the result	Independent conclusions
4	Controls	Defends the decision	Evaluation
5	Conducts reflection	Fills out the declaration	Upholding integrity

ANNEX 3

FRAGMENTS OF EDUCATIONAL SCENARIOS OF THE USE OF ARTIFICIAL INTELLIGENCE IN THE PROCESS OF TEACHING TECHNICAL DISCIPLINES

Table D. 3.1

Educational scenario 1. Studying the principle of operation of an asynchronous electric motor

Script element	Content
Discipline	Electromechanics
Topic	Asynchronous electric motor
Purpose of the lesson	Developing an understanding of the working principle and main characteristics
Student's educational activities	Analysis of explanations, independent formulation of conclusions
AI tool	ChatGPT
The role of AI	Explanatory, reference
CONTROL	Oral interview, short written report
Learning outcome	Understanding the physical processes in an electric motor

Table D. 3.2

Educational scenario 2. Analysis of the technical characteristics of an electric drive

Script element	Content
Discipline	Electric drive
Topic	Operating modes of electric drives
Purpose of the lesson	Teach how to analyze equipment passport data
Student's educational activities	Analysis of parameters, formation of conclusions
AI tool	ChatGPT, Copilot
The role of AI	Analytical, reference
CONTROL	Parameter table analysis
Learning outcome	Analytical and engineering skills
Результат навчання	Аналітичні та інженерні навички

Table D. 3.3

Educational scenario 3. Development of a PLC control algorithm

Script element	Content
Discipline	Automatics
Topic	Control algorithms
Purpose of the lesson	Development of algorithmic thinking
Student's educational activities	Algorithm analysis and modification

Continuation of Table D. 3.3

Script element	Content
AI tool	ChatGPT, GitHub Copilot
The role of AI	Auxiliary (draft)
CONTROL	Algorithm protection, flowchart
Learning outcome	Ability to develop control algorithms

Table D. 3.4

Educational scenario 4. Selection of sensors for an automatic control system

Script element	Content
Discipline	Automatic control theory
Topic	Sensors and actuators
Purpose of the lesson	Formation of project competencies
Student's educational activities	Classification, justification of choice
AI tool	ChatGPT
The role of AI	Informational
CONTROL	Written justification
Learning outcome	Project skills

Table D. 3.5

Educational scenario 5. Diagnostics of electromechanical system faults

Script element	Content
Discipline	Operation of electromechanical systems
Topic	Typical faults
Purpose of the lesson	Developing technical analysis skills
Student's educational activities	Analysis of causes and solutions
AI tool	ChatGPT
The role of AI	Reference
CONTROL	Case analysis
Learning outcome	Technical diagnostic skills

Table D. 3.6

Educational Scenario 6. Reflection and Academic Integrity

Script element	Content
Discipline	All technical disciplines
Topic	Responsible use of AI
Purpose of the lesson	Formation of academic culture
Student's educational activities	Filling out the AI use declaration

Continuation of Table D. 3.6

Script element	Content
AI tool	All allowed
The role of AI	Declarable
CONTROL	Declaration verification
Learning outcome	Conscious use of AI

ANNEX 4

FRAGMENTS OF EDUCATIONAL SCENARIOS FOR ONLINE AND BLENDED LEARNING USING ARTIFICIAL INTELLIGENCE

Table D. 4.1

Scenario 1. Online study of the principle of operation of an electromechanical system

Script element	Content
Training format	Online (synchronous + asynchronous)
Discipline	Electromechanics
Topic	Asynchronous electric motor
Student's educational activities	Watch the video lecture, analyze the explanation of AI
AI tool	ChatGPT
The role of AI	Explanatory
CONTROL	Online test + short written presentation
Learning outcome	Understanding the principle of engine operation

Table D. 4.2

Scenario 2. Blended Learning in Drive Analysis

Script element	Content
Training format	Mixed
Discipline	Electric drive
Topic	Operating modes of electric drives
Student's educational activities	Independent analysis + face-to-face discussion
AI tool	ChatGPT, Copilot
The role of AI	Reference
CONTROL	Parameter table analysis
Learning outcome	Analytical skills

Table D. 4.3

Scenario 3. Online development of PLC control algorithm

Script element	Content
Training format	Online
Discipline	Automation, PLC
Topic	Control algorithms
Student's educational activities	Algorithm development, simulation
AI tool	ChatGPT, GitHub Copilot
The role of AI	Chernetkova
CONTROL	Algorithm protection in an online session
Learning outcome	Algorithmic thinking

Table D. 4.5

Scenario 4. Online selection of sensors for the control system

Script element	Content
Training format	Online
Discipline	Automatic control theory
Topic	Sensors and actuators
Student's educational activities	Requirements analysis and sensor selection
AI tool	ChatGPT
The role of AI	Informational
CONTROL	Written technical justification
Learning outcome	Project competencies

Table D. 4.6

Scenario 5. Mixed format fault diagnosis

Script element	Content
Training format	Mixed
Discipline	Operation of electromechanical systems
Topic	Typical faults
Student's educational activities	Online case analysis + face-to-face discussion
AI tool	ChatGPT
The role of AI	Reference
CONTROL	Solving a situational problem
Learning outcome	Technical analysis skills

Table D. 4.7

Scenario 6. Online reflection and academic integrity

Script element	Content
Training format	Online
Discipline	All technical disciplines

Continuation of Table D. 4.7

Script element	Content
Topic	Responsible use of AI
Student's educational activities	Filling out the declaration
AI tool	Declared
The role of AI	Declarable
CONTROL	Declaration verification
Learning outcome	Academic culture

Table D. 4.8

Comparison of scenarios for online and blended learning

Criterion	Online	Mixed
Level of independence	High	Average
Teacher control	Online protection	Combined
The role of AI	Support	Support
Communication	Asynchronous	Face-to-face + online
Efficiency	Theory, algorithms	Practice, analysis

ANNEX 5

SAMPLE PROMPTS FOR USING ARTIFICIAL INTELLIGENCE IN TEACHING TECHNICAL SUBJECTS

Table D. 5.1

General methodological prompts for technical disciplines

Purpose of use	Prompt example	The role of AI
Explanation of the concept	"Explain the working principle of [technical object] in simple words for a technical student"	Explanatory
Clarification of terms	"Explain the meaning of the terms used in the topic [topic name]"	Reference
Structuring the material	"Propose a logical structure for a topic in the discipline [name of discipline]"	Chernetkova
Preparing for class	"What should I pay attention to when studying the topic [topic name]?"	Approximate

Table D. 5.2

Prompts for the discipline “Electric Machines”

Educational task	Prompt example	Limitation
Explanation of the working principle	"Explain the principle of operation of an asynchronous electric motor with a squirrel-cage rotor"	Without copying to report

Continuation of Table D. 5.2

Educational task	Prompt example	Limitation
Parameter analysis	"What are the main parameters of an induction motor and how do they affect its operation?"	Check with the textbook
Physical processes	"Describe the process of creating a rotating magnetic field in the stator"	Independent conclusions are required.
Practical application	"Give examples of the use of asynchronous motors in automation systems"	Examples to adapt

Table D. 5.3

Prompts for the discipline "Building, debugging and maintenance of automation devices"

Educational task	Prompt example	The role of AI
Analysis of characteristics	"Explain the mechanical characteristics of an electric drive and its features"	Reference
Operating modes	"What operating modes of an electric drive are used in industry?"	Explanatory
Comparison	"Compare the speed control of induction and synchronous motors"	Analytical
Common mistakes	"What are the typical errors that occur when operating electric drives?"	Approximate

Table D. 5.4

Prompts for the discipline "Automatic Control Theory"

Educational task	Prompt example	Methodological caveat
Control algorithm	"Describe the general logic of the control algorithm of the "start-run-stop" system"	Do not use a ready-made algorithm
Emergency modes	"What emergency modes should be provided for in the control system?"	Check standards
System analysis	"Explain the principle of operation of a closed-loop automatic control system"	Generalization without formulas
Comparison of methods	"Compare relay and program control"	Independent conclusion

Table D. 5.5

PLC programming prompts

Task type	Prompt example	Allowed result
Control logic	"Describe the logic of a PLC program for controlling a motor"	Text description
Structured Text	"Explain the Structured Text syntax for conditional statements"	Explanation, not code
Error analysis	"What logical errors often occur in PLC programs?"	Analytical list
Optimization	"What should you pay attention to when optimizing a PLC program?"	Recommendations

Table D. 5.6

Prompts for reflection and academic integrity

Goal	Prompt example	Result
Self-esteem	"What did I understand after completing this task?"	Reflection
Analysis of the role of AI	"At what point was AI useful?"	Awareness
Independence	"What decisions have I made on my own?"	Responsibility
Improvement	"What can be improved in a solution without AI?"	Critical thinking

Table D. 5.7

Prohibited prompts and justification for their inadmissibility

Category	Example of a prohibited prompt	Reason for the ban	Acceptable alternative
Full generation of work	"Write a complete report on laboratory work in electromechanics"	Substitution of independent work	"Explain the structure of the report"
PLC code generation	"Write a PLC program to control the motor"	Copyright infringement	"Describe the logic of the algorithm"
Automatic calculations	"Calculate all the parameters of the electric drive"	Lack of analysis	"Explain the sequence of calculations"
Copying responses	"Give ready answers to the test questions"	Integrity violation	"What should you pay attention to when answering?"
Imitation of protection	"Write answers for the defense of the work"	Bypassing the assessment	"What questions can be asked?"
Translation substitution	"Translate and adapt the text as my own"	Hiding AI	"Help check the translation"
Bypassing control	"How to bypass the AI check?"	Intention of violation	Missing
Data falsification	"Generate experimental data"	Falsification	"Explain the data collection method"
Full code optimization	"Optimize the code and make it perfect"	Loss of authorship	"Explain the principles of optimization"
Formal reflection	"Write a reflection for me"	Imitation of awareness	"Ask questions for self-analysis"

ANNEX 6

RECOMMENDED AI TOOLS FOR USE IN THE PROCESS OF TEACHING TECHNICAL DISCIPLINES

Table D. 6.1

Universal AI tools for educational support

Tool name	Main purpose	Educational tasks	The role of AI
ChatGPT	Explanation generation, text analysis	Explanation of the principles of system operation, analysis of algorithms	Explanatory
Microsoft Copilot	Analysis of technical documentation	Working with instructions and standards	Reference
Grammarly	Language support	Proofreading of technical texts in English	Technical

Table D. 6.2

AI tools for PLC programming and training

Tool	Environment	Supported languages	Educational purpose
GitHub Copilot	IDE, PLC projects	Structured Text	Syntax hints, logic analysis
Siemens TIA Portal	Siemens PLC	LAD, FBD, ST	Design, simulation
CODESYS	IEC 61131-3	LAD, FBD, ST, IL	Universal PLC training
Automation Studio	PLC, electric drive	FBD, ST	Control systems modeling

Table D. 6.3

AI tools for modeling electromechanical systems

Tool	Type of systems	Main features	Educational application
MATLAB / Simulink	Electric drive	Modeling, dynamics analysis	Laboratory, coursework
ANSYS Motor-CAD	Electric motors	Analysis of electromagnetic processes	Project tasks
PSCAD	Electric power industry	Transient process modeling	Analysis of operating modes

Table D. 6.4

AI tools for analyzing technical information

Tool	Type of materials	Appointment	Educational effect
ChatGPT	Schemes, algorithms	Explanation of the logic of work	Increasing understanding

Continuation of Table D. 6.4

Tool	Type of materials	Appointment	Educational effect
Copilot	Technical texts	Standards analysis	Learning optimization
PDF AI Readers	Manuals, passports	Finding and explaining fragments	Working with documentation

Table D. 6.5

Tools for monitoring academic integrity

Tool	Control object	Function	Methodological purpose
Turnitin	Text works	AI generation detection	Independence control
Plagiarism Checker X	Written reports	Borrowings search	Ensuring integrity

Table D. 6.6

Correspondence of tools to academic disciplines

Discipline	Recommended AI tools
Electromechanics	ChatGPT, MATLAB, ANSYS
Electric drive	Simulink, CODESYS
Automatics	TIA Portal, CODESYS
PLC programming	GitHub Copilot, TIA Portal
Systems operation	ChatGPT, Copilot

Методичні рекомендації присвячено питанням використання штучного інтелекту в процесі викладання технічних дисциплін для іноземних здобувачів освіти на прикладі спеціальностей G3 «Електрична інженерія» та G7 «Автоматизація, комп'ютерно-інтегровані технології та робототехніка». У виданні розглянуто сучасні підходи до інтеграції інструментів штучного інтелекту в освітній процес з урахуванням дидактичних, методичних, етичних і нормативно-правових вимог. У методичних рекомендаціях проаналізовано особливості навчання іноземних здобувачів освіти технічного профілю, окреслено методичні можливості використання штучного інтелекту під час викладання теоретичного матеріалу, організації практичних і самостійних робіт, а також контролю та оцінювання навчальних результатів. Особливу увагу приділено питанням академічної доброчесності, відповідального використання цифрових технологій і запобігання ризикам неетичного застосування штучного інтелекту в освітньому процесі. Методичні рекомендації адресовано викладачам технічних дисциплін закладів вищої освіти, методистам, розробникам освітніх програм, а також можуть бути корисними адміністративним працівникам, відповідальним за забезпечення якості освіти, та іноземним здобувачам освіти з метою формування усвідомленого ставлення до використання інструментів штучного інтелекту в навчальній діяльності.

Навчальне видання

ВИКОРИСТАННЯ ШТУЧНОГО ІНТЕЛЕКТУ В ПРОЦЕСІ ВИКЛАДАННЯ ТЕХНІЧНИХ ДИСЦИПЛІН ДЛЯ ІНОЗЕМНИХ ЗДОБУВАЧІВ ОСВІТИ

Методичні рекомендації

Англійською мовою

Формат 60×84$^{1}/_{16}$. *Ум. друк. арк.* 6,51. *Тираж* 100 пр. *Зам.* № 534-790.

ВИДАВЕЦЬ І ВИГОТОВЛЮВАЧ
Товариство з обмеженою відповідальністю фірма «Іліон».
54038, м. Миколаїв, вул. Бузника, 5/1.
Свідоцтво суб'єкта видавничої справи ДК № 1506 від 25.09.2003 р.

Methodological recommendations are devoted to the issues of using artificial intelligence in the process of teaching technical disciplines for foreign students using the example of specialties G3 "Electrical Engineering" and G7 "Automation, Computer-Integrated Technologies and Robotics". The publication considers modern approaches to integrating artificial intelligence tools into the educational process, taking into account didactic, methodological, ethical and regulatory requirements.

The methodological recommendations analyze the peculiarities of teaching foreign students of technical education, outline the methodological possibilities of using artificial intelligence when teaching theoretical material, organizing practical and independent work, as well as monitoring and evaluating learning outcomes. Particular attention is paid to the issues of academic integrity, responsible use of digital technologies, and preventing the risks of unethical use of artificial intelligence in the educational process.

The methodological recommendations are addressed to teachers of technical disciplines in higher education institutions, methodologists, developers of educational programs, and may also be useful to administrative staff responsible for ensuring the quality of education, and foreign students in order to form a conscious attitude towards the use of artificial intelligence tools in educational activities.

ISBN 978-617-534-790-4