MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

NATIONAL TECHNICAL UNIVERSITY
«KHARKIV POLYTECHNIC INSTITUTE»

Department of Automated Electromechanical Systems

«APPROVED»
Head of the Department of Automated Electromechanical Systems

_____ Bohdan VOROBIOV
(signature) (initials and surnames)

«_____»_____2023 year

WORKING PROGRAM OF THE EDUCATIONAL COURSE

Pre-graduation Practice
(name of the course)

level of higher education *the second (master`s) level*
first (bachelor) / second (master's)

field of knowledge *14 Electrical engineering*
(code and name)

specialty *141 Electrical power engineering, electrical engineering and electromechanics*
(code and name)

Professional program *Electric Drive, Mechatronics and robotics*
(code and name)

type of course *Obligatory educational components: Professional training;*
(general training / professional training)

mode of study *full-time*
(full-time / part-time)

Kharkiv – 2023 year

APPROVAL LIST

Working program of the educational course *Pre-graduation Practice*
(name of discipline)

Developers:

Professor at the Department of AEMS, associate professor, cand. of tech. sc. Mykola ANISHCHENKO
(present post, a degree and academic rank) (signature) (initials and surnames)

Associate professor at the Department of AEMS, associate professor, cand. of tech. sc. Tetiana KUNCHENKO
(present post, a degree and academic rank) (signature) (initials and surnames)

Senior lecturer at the Department of AEMS, cand. of tech. sc. Oleksii SEMIKOV
(present post, a degree and academic rank) (signature) (initials and surnames)

The working program was considered and approved at the meeting of the department of *«Automated Electromechanical Systems»*
(name of the department)

Minutes from « 21 » 09 2023 year № 9

Head of Department AEMS _____ Bohdan VOROBIOV
(signature) (initials and surnames)

LIST OF AGREEMENT

Professional program	Guarantor of the education programme	Signature and date
Electric Drive, Mechatronics and robotics	Vira Shamardina	

Head of the Specialty Support Unit _____ *O.P. Lazurenko*
(signature) (initials and surnames)

«_____» _____2023 year

LIST OF CONFIRMATION OF THE WORKING EDUCATION PROGRAM

Date of the meeting of the department - the developer of WPEC	Minutes number	Signature of the head of the department	Guarantor of the education programme

PURPOSE, COMPETENCE, RESULTS OF TEACHUNG, A STRUCTURAL, AND LOGICAL SCHEME OF STUDY EDUCATIONAL COURSE

Course objective: Enhancement of practical experience and skills in independent work in the field, a creative approach to solving engineering tasks, deepening and consolidating the knowledge obtained during the university studies, and collecting materials for use in the diploma project are the main objectives of the Pre-graduation Practice.

Competencies: The ability for abstract thinking, analysis, and synthesis. The ability to apply knowledge in practical situations. Proficiency in communicating in the state language both orally and in writing. Capability for researching, processing, and analyzing information from various sources. Skill in identifying, formulating, and solving problems. Ability to work in a team and autonomously. Capability to exercise rights and fulfill responsibilities as a member of society, understanding the values of a civil (free democratic) society, and recognizing the need for its sustainable development, the supremacy of law, and the rights and freedoms of individuals and citizens in Ukraine. Ability to preserve and enhance moral, cultural, scientific values, and societal achievements based on an understanding of the history and regularities of the subject area, its place in the general system of knowledge about nature and society, and in the development of society, technology, and technology, using various types and forms of physical activity for active recreation and maintaining a healthy lifestyle. The ability to solve practical problems using computer-aided design and calculations (CAD). The ability to solve practical problems involving methods of mathematics, physics, and electrical engineering. Ability to solve complex specialized problems and practical issues related to the operation of electrical systems and networks, the electrical part of stations and substations, and high-voltage equipment. Capability to address complex specialized problems and practical issues related to metrology, electrical measurements, the operation of automatic control devices, relay protection, and automation. Capability to address complex specialized problems and practical issues related to the operation of electrical machines, devices, and automated electrical drives. Capability to address complex specialized problems and practical issues related to the production, transmission, and distribution of electrical energy. Ability to develop projects for electrical, electrical, and electromechanical equipment in compliance with legislation, standards, and technical specifications. Proficiency in performing professional duties while adhering to safety, labor protection, industrial sanitation, and environmental protection requirements. Awareness of the need to increase the efficiency of electrical, electrical, and electromechanical equipment. Awareness of the need to constantly expand personal knowledge of new technologies in electrical engineering, electrical engineering, and electromechanics. The ability to promptly implement effective measures in emergency situations in electrical power and electromechanical systems. The ability and readiness to understand and analyze economic problems and social processes, being an active subject of economic activity. The ability to develop simple designs for electrical and electrical objects and assess the mechanical strength of developed

designs. Acquisition and use of professional knowledge and understanding related to the process of using and consuming electrical energy by means of electric drive while adhering to specified parameters of technological processes and the quality of electrical energy. Acquisition and use of professional knowledge and understanding related to the development and operation of mechatronic devices and systems while adhering to specified parameters of technological processes. Ability to conduct appropriate calculations for the analysis of transient and steady-state operating modes of electric drives and mechatronic modules and systems. Ability to create and calculate diagrams of electrical installations for various purposes, determine the composition of their equipment, and optimize their operating modes.

Program results of training: To know and understand the principles of operation of electrical systems and networks, power equipment of electrical stations and substations, protective grounding devices, and lightning protection, and be able to use them to solve practical problems in professional activities. To know and understand the theoretical foundations of metrology and electrical measurements, the principles of operation of automatic control devices, relay protection, and automation, and have skills in conducting relevant measurements and using these devices to solve professional tasks. To know the principles of operation of electrical machines, devices, and automated electrical drives and be able to use them to solve practical problems in professional activities. To know the principles of operation of bioenergy, wind energy, hydroenergy, and solar energy installations. To know the basics of the theory of electromagnetic fields, methods of calculating electrical circuits, and be able to use them to solve practical problems in professional activities. To apply software, microcontrollers, and microprocessor technology to solve practical problems in professional activities. To analyze processes in electrical power, electrical engineering, and electromechanical equipment, relevant complexes, and systems. To choose and apply appropriate methods for the analysis and synthesis of electromechanical and electrical power systems with specified indicators. To assess the energy efficiency and reliability of electrical power, electrical engineering, and electromechanical systems. To find necessary information in scientific and technical literature, databases, and other sources of information, evaluate its relevance and reliability. To communicate fluently in the state and foreign languages both orally and in writing, discuss the results of professional activities with specialists and non-specialists, and argue one's position on discussion issues. To understand the basic principles and objectives of technical and environmental safety of objects in electrical engineering and electromechanics, taking them into account when making decisions. To understand the importance of traditional and renewable energy for the successful economic development of the country. To understand the principles of European democracy and respect for citizens' rights, taking them into account when making decisions. To understand and demonstrate good professional, social, and emotional behavior, adhere to a healthy lifestyle. To know the requirements of regulatory acts related to engineering activities, intellectual property protection, labor protection, safety, and industrial hygiene, taking them into account when making decisions. To solve complex specialized problems in the design and maintenance of

electromechanical systems, electrical equipment of power stations, substations, systems, and networks. To be able to learn independently, acquire new knowledge, and improve skills in working with modern equipment, measurement techniques, and applied software. To apply suitable empirical and theoretical methods to reduce electrical energy losses in its production, transportation, distribution, and use. To solve professional problems in the design, installation, and operation of electrical power, electrical engineering, and electromechanical complexes and systems. To know the essence of basic economic categories, scientific foundations, and ways to increase production and resource savings. To know and be able to develop simple designs of electrical and electrical objects and evaluate the mechanical strength of developed designs. To know and understand the processes of using and consuming electrical energy by means of electric drive while adhering to specified parameters of technological processes and the quality of electrical energy. To know and understand the principles of organizing the development and operation of mechatronic devices and systems while adhering to specified parameters of technological processes. To be able to conduct calculations for the analysis of transient and steady-state operating modes of electric drives and mechatronic modules and systems. To know and understand the principles of compiling and calculating diagrams of electrical installations for various purposes, determine the composition of their equipment, and optimize their operating modes.

Structural and logical scheme of studying course

Previous courses:	**The following disciplines:**
Intellectual Property	Attestation
Innovative entrepreneurship and management of startup projects	
Foreign language for professional purposes	
Fundamentals of scientific research	
Labor and professional safety	
Reliability and Diagnostics	
Problems, Technologies, and Prospects of Electrical Power engineering and electromechanics	
Computer Numerical Control of Mechatronic Systems p. 1	
Mobile Mechatronic and Robotic Systems	
Design of Mechatronic Systems	
Computer Numerical Control of Mechatronic Systems p. 2	
Simulation of microprocessor electric drives of robotic and mechatronic systems	
Modern methods of mechatronic systems drives controlling	
Electric drive of mechatronic systems with microprocessor control	
Intelligent Control Systems in Mechatronics	
Dynamics of Mechatronic and Robotic Systems	

DESCRIPTION OF THE EDUCATIONAL COURSE
(distribution of study time by semester and types of training sessions)

Semester	Total number of hours / ECTS credits	of them		By type of classes (hours)			Individual tasks (C, CG, R, YR)	Current control	Semester control	
		Classroom (hours)	Independent work (hours)	Lectures	Laboratory work	Practical studies, seminars		Control tasks (number of tasks)	Tests	Examination
1	2	3	4	5	6	7	8	9	10	11
3	450/15	0	450	0	0	0	—	—	+	−

C – Calculated task

The number of classroom hours to the total number ratio is (0/450)*100% = 0%.

EDUCATIONAL COURSE STRUCTURE

№	Types of training (L, LW, PS, IW)	Number of hours	The number of the semester (if the discipline is taught in several semesters). Names of content modules. Name of topics and questions of each class. Tasks for independent work.	Recommended reading (basic, auxiliary)
1	2	3	4	5
1.	IW	50	Topic 1. Technological processes, designs, and operation principles of the mechanism or unit specified in the topic of the diploma project.	1, 3, 5, 9, 10, 15
2.	IW	50	Topic 2. Sequence and timing of technological operations, their interrelation. Controlled technological parameters and accuracy control requirements.	1, 4, 5, 7, 11…15
3.	IW	50	Topic 3. Regulated technological parameters and quality indicators of the automatic control system.	2, 5, 9…12
4.	IW	50	Topic 4. Requirements for optimizing the technological process and experimental characteristics. Operating conditions of sensors and the automatic control system as a whole.	1…15
5.	IW	50	Topic 5. Functional and kinematic scheme of the mechanism along with the electric drive, indicating geometric dimensions and the weight of individual elements.	3, 5…7, 12…15
6.	IW	50	Topic 6. Static indicators of control objects. Static loads of the main technological modes of operation of the production unit, moments of inertia, transmission ratios of individual links of the kinematic scheme; total induced moment of inertia of the engine-mechanism system; friction coefficients in bearings; acceleration and deceleration values, operating speeds of the mechanism.	1…7, 9…15
7.	IW	50	Topic 7. Selection of power components of the electric drive.	16…18
8.	IW	50	Topic 8. Dynamic modes. Verification of the selection of power components of the electric drive. Dynamic indicators of control objects.	1…7, 9…18
9.	IW	50	Topic 9. Features of the Development of Design Documentation and Implementation. Intellectual Property	1…18
Total (hours)		**450**		

INDEPENDENT WORK

№	The name of types of independent work	Number of hours
1.	Application of learning outcomes in practice	150
2.	Completion of an individual task	150
3.	Other types of independent work	150
	Total	450

INDIVIDUAL TASKS

Report on the Pre-graduation Practice

(individual task type)

№	The name of the individual task and (or) its sections	Dates (in which week)
1.	**The electric drive of the mechanism**	
	– task assignment	1
	– review of electric drives used in the mechanism	1
	– determination of coordinates and performance indicators influenced by the electric drive	2
	– development of a kinematic scheme	2
	– calculation of static and dynamic modes of operation of the working element of the mechanism	3
	– selection of power components for the electric drive of the mechanism	4
	– calculation of static and dynamic modes of operation of the electric drive of the mechanism	5
	– verification of the selection of power components for the electric drive of the mechanism	6
	– mathematical description of the electric drive as a control object	7
	– compilation of design documentation	8
	– task defense	9

TEACHING METHODS

The learning process for this discipline involves independent work and consultations.

During independent work, the student should study the topics outlined in the recommended literature specified in the curriculum for the academic discipline, review material from previous courses used in completing individual assignments, and prepare a report based on the results of the individual task.

CONTROL METHODS

The quality control system for students' education includes checking the results of independent work in the form of a report on the Pre-graduation Practice and final assessment in the form of tests.

The control of independent work results involves verifying the relevance of the literature used in reviewing the mechanism and its correspondence to the discussed issues, the correctness of the created diagrams, calculations, and obtained diagrams.

The final assessment is conducted in an oral form based on the materials of independent work.

A student is considered eligible for the tests in the academic discipline if they have completed the assignments for independent work.

DISTRIBUTION OF marks WHICH A STUDENT GETS AND SCALE OF ASSESSMENT OF KNOWLEDGE AND SKILLS (national and ECTS)

Table 1. Distribution of points for evaluating a student's current performance

Report for practice	Diary for practice	Feedback from the supervisor of the internship from the company	Tests	Sum
40	20	10	30	100

Criteria and system for grading students' knowledge and skills

According to the ECTS system, the grading system should be understood as a complex of methods (written, oral and practical tests, exams, projects, etc.) used to assess the achievement of the expected learning outcomes by students.

Successful grading of learning results is a condition for awarding credits to a student. Therefore, statements about the results of studying program components should always be accompanied by clear and appropriate grading criteria for awarding credits. This makes it possible to state whether the student has acquired the necessary knowledge, understanding, and competencies.

Grading criteria are descriptions of what a learner is expected to do to demonstrate the achievement of a learning outcome.

The main conceptual concepts of the system of assessment of students' knowledge and skills are:

1. To improve the quality of training and competitiveness of specialists by stimulating independent and systematic work of students during the academic semester, by establishing constant feedback from teachers to each student and timely adjustment of their learning activities.

2. Objectivity of students' knowledge assessment is enhanced by control during the semester using a 100-point scale (Table 2). Grades are necessarily converted to the national scale (with the state semester grade of «excellent», «good», «satisfactory» or «unsatisfactory») and to the ECTS scale (A, B, C, D, E, FX, F).

Table 2: Knowledge and skills rating scale: national and ECTS

The amount of points for all types of educational activities	**ECTS rating**	**National scale rating**	**Rating criteria**	
			positive	**negative**
1	2	3	4	5
90-100	A	Excellent	- Deep knowledge of the teaching material in the basic and supplementary literature; - ability to analyze the studied processes in their interconnection and development; - ability to carry out theoretical calculations; - answers to questions are concise, logical and consistent; - the ability to solve complex practical problems.	Answers to questions may contain minor inaccuracies
82-89	B	Good	- Deep knowledge in the scope of mandatory material; – ability to give reasoned answers; – the ability to solve complex practical problems.	Answers to the questions contain certain inaccuracies
75-81	C	Good	– Strong knowledge of the material being studied and its practical application; – ability to give reasoned answers and carry out theoretical calculations; – ability to solve practical problems.	Inability to solve complex practical problems
64-74	D	Satisfactory	– Knowledge of the fundamental points of the studied material and its practical application; – the ability to solve simple practical problems.	– Inability to give reasoned answers to questions; – inability to analyze the

				material presented and carry out calculations – inability to solve practical problems
60-63	E	Satisfactory	– Knowledge of the fundamental points of the studied material; – the ability to solve the simplest practical problems.	– Ignorance of certain questions from the material; – inability to consistently express an opinion; – inability to solve practical problems
35-59	FX	Unsatisfactory with the possibility of reassembly	– Additional study of the material can be completed in the terms provided by the curriculum.	– Ignorance of the basic fundamental points of the educational material; – points errors in answering questions; – inability to solve simple practical problems
1-34	F	Unsatisfactory with the compulsory re-study of the discipline	-	– Complete lack of knowledge of a significant part of the material; – significant errors in answering questions; – ignorance of the main fundamental points; – inability to navigate when solving simple practical problems

Table 3. Scale of assessment of knowledge and skills: national and ECTS

The amount of points for all types of educational activities	ECTS rating	National scale rating
90 ... 100	A	Excellent
82 … 89	B	Good
74 … 81	C	
64 … 73	D	Satisfactory
60 … 63	E	
35 … 59	FX	Unsatisfactory with the possibility of reassembly
0 … 34	F	Unsatisfactory with the compulsory re-study of the discipline

EDUCATIONAL AND METHODICAL SUPPORT FOR EDUCATIONAL COURES

Educational and methodological support of the discipline includes:
- learning guidelines for independent work;
- questions for the final knowledge assessment in the form of tests.

The components of the educational and methodological support of the discipline are located on the website of the Department of Automated Electromechanical Systems: http://web.kpi.kharkov.ua/aems/uk/complecs-uk/

RECOMMENDED LITERATURE

Basic literature

1	Die Elektrotechnik und die elektrischen Antriebe Lehr- und Nachschlagebuch für Studierende und Ingenieure. Wilhelm Lehmann. 6th ed. 1962. 433 p.
2	Theory of Automatic Control. M. A. Aizerman. 1963. 519 p.
3	Electric Motor Handbook. Beaty H.W., Kirtley J. 1998. 398 p.
4	Control of Electrical Drives. Leonhard W. 3rd ed. 2003. 460 p.
5	Electric Motors and Drives. Austin Hughes. 3rd ed. 2006. 410 p.
6	Electricity and Electronics. Stan Gibilisco. 4th ed. 2006. 699 p.
7	Propulsion Systems for Hybrid Vehicles. John M. Miller. 2008. 455 p.
8	Intellectual Property Rights. Bosworth D. L. 1986. 300 p.

Additional literature

9	Coughanowr and Koppel, Process Systems Analysis and Control, McGraw-Hill, 1965, pp. 67-70.
10	Seborg, D.E., T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control, John Wiley, 1989, pp. 86-93.
11	Digital Control of Electric Drives. R. Koziol, J. Sawicki and L. Szklarski. 1992. 206 p.
12	Marlin, T.E., Process Control: Designing Processes and Control Systems for Dynamic Performance, McGraw-Hill, 1995
13	Handbook Of Batteries. David Linden, Thomas B. Reddy. 3rd ed. 2002. 1453 p.
14	Electric Vehicle: Technology Explained. James Larminie. 2003. 302 p.
15	Modern Electric, Hybrid and Fuel Cell Vehicles. Mehrdad Ehsani. 2005. 417 p.

Information resources on the internet

16	https://www.baldor.com/brands/baldor-reliance/products
17	https://www.weg.net/catalog/weg/US/en/Electric-Motors/c/US_MT
18	https://www.semikron-danfoss.com/service-support/downloads/detail/semikron-product-catalogue-en.html