МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені Ігоря Сікорського»

ЗАТВЕРДЖЕНО
Вченою радою КПІ ім. Ігоря Сікорського
(протокол № 5 від «30» 06 2020 р.)
Голова Вченої ради
_____ Михайло ІЛЬЧЕНКО

ЕЛЕКТРОМЕХАНІЧНІ СИСТЕМИ АВТОМАТИЗАЦІЇ, ЕЛЕКТРОПРИВОД ТА ЕЛЕКТРОМОБІЛЬНІСТЬ

ELECTROMECHANICAL AUTOMATION SYSTEMS, ELECTRICAL DRIVE AND ELECTROMOBILITY

ОСВІТНЬО-ПРОФЕСІЙНА ПРОГРАМА

першого (бакалаврського) рівня вищої освіти

за спеціальністю	**141 – «Електроенергетика, електротехніка та електромеханіка»**
галузі знань	**14 – «Електрична інженерія»**
кваліфікація	**Бакалавр з електроенергетики, електротехніки та електромеханіки**

Введено в дію наказом ректора
КПІ ім. Ігоря Сікорського
наказ № 1/231 від «08» 07 2020 р.

Київ – 2020

PREAMBLE

DEVELOPED by the project team:

Project team leader:

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Project team members:

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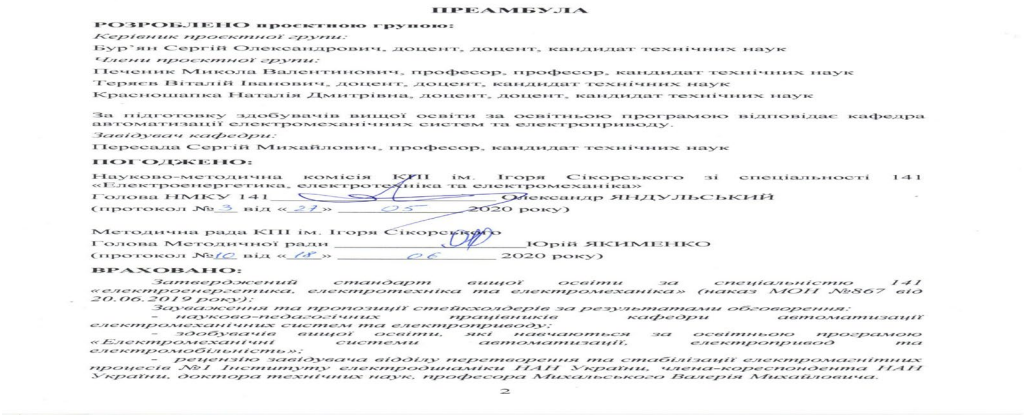
Teryaev Vitalii Ivanovich, associate professor, candidate of technical sciences

Krasnoshapka Nataliia Dmytrivna, associate professor, candidate of technical sciences

The Department of Electromechanical Automation Systems and Electrical Drive is responsible for training of higher education students according to the educational program.

Head of Department:

Peresada Serhii Mykhailovych, professor, doctor of technical sciences



ПРЕАМБУЛА

РОЗРОБЛЕНО проектною групою:
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За підготовку здобувачів вищої освіти за освітньою програмою відповідає кафедра автоматизації електромеханічних систем та електроприводу.
Завідувач кафедри:
Пересада Сергій Михайлович, професор, кандидат технічних наук

ПОГОДЖЕНО:
Науково-методична комісія КПІ ім. Ігоря Сікорського зі спеціальності 141 «Електроенергетика, електротехніка та електромеханіка»
Голова НМКУ 141 _____ Олександр ЯНДУЛЬСЬКИЙ
(протокол № 3 від «21» 05 2020 року)

Методична рада КПІ ім. Ігоря Сікорського
Голова Методичної ради _____ Юрій ЯКИМЕНКО
(протокол №10 від «18» 06 2020 року)

ВРАХОВАНО:
Затверджений стандарт вищої освіти за спеціальністю 141 «електроенергетика, електротехніка та електромеханіка» (наказ МОН №867 від 20.06.2019 року);
Зауваження та пропозиції стейкхолдерів за результатами обговорення:
– науково-педагогічних працівників кафедри автоматизації електромеханічних систем та електроприводу;
– здобувачів вищої освіти, які навчаються за освітньою програмою «Електромеханічні системи автоматизації, електропривод та електромобільність»;
– рецензію завідувача відділу перетворення та стабілізації електромагнітних процесів №1 Інституту електродинаміки НАН України, члена-кореспондента НАН України, доктора технічних наук, професора Михальського Валерія Михайловича.

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INCLUDED:

- *Approved standard of higher education in the specialty 141 "electric power, electrical engineering and electromechanics" (order of the Ministry of Education and Science №867 from 20.06.2019);*
- *Comments and suggestions of stakeholders based on the results of the discussion:*
- *scientific and pedagogical workers of the department of automation of electromechanical systems and electric drive;*
- *applicants for higher education who study under the educational program "Electromechanical automation systems, electrical drive and electromobility";*
- *review of the head of the department of transformation and stabilization of electromagnetic processes №1 of the Institute of Electrodynamics of the NAS of Ukraine, corresponding member of the NAS of Ukraine, doctor of technical sciences, professor Mykhalsky Valerii Mykhailovych.*

CONTENTS

1. EDUCATIONAL PROGRAM PROFILE

from specialty 141 – «Electric energy, electrical engineering and electromechanics»

1 - General information	
Full name of IHE and institute / faculty	A national technical university of Ukraine is the "Kyiv polytechnic institute of the name of Ihor Сікорського", faculty of electric energy and automations
Higher education degree and title of qualification in the original language	A degree - bachelor's degree Qualification - bachelor's degree from an electric energy, electrical engineering and electromechanics
The official name of the EP	Electromechanical automation systems, electric drive and electromobility
Type of diploma and scope of EP	Bachelor's degree, single, 240 credits, term of study 3 years 10 months
Availability of accreditation	Certificate НД № 1192630 (070932) dated 25.09.2017, issued by the Ministry of Education and Science of Ukraine, valid until 01.07.2023.
Cycle/level of HE	NQF of Ukraine - level 7, FQ-EHEA - first cycle, EQF-LLL - level 6
Prerequisites	Availability of complete general secondary education
Language(s) of instruction	Ukrainian, English
Validity of the EP	Until the next accreditation
Internet address of the permanent placement of the educational program	https://fea.kpi.ua https://osvita.kpi.ua
2 - The purpose of the educational program	
Training of a specialist capable of solving complex specialized problems and practical problems in the electrical, electromechanical and electromobile industries, which involves the application of theories and principles of electromechanical automation systems and electric drives.	
3 - Characteristics of the educational program	
Subject area	*Objects of study and activity:* enterprises power complex, electrical and electromechanical services of organizations; production, transmission, distribution and conversion of electricity at power plants, power grids and systems; electrotechnical equipment, electromechanical and switching equipment, electromechanical and electrotechnical complexes and systems. *Purpose of training:* Training of capable specialists to solve specialized problems and practical problems of power engineering, electrical engineering and electromechanics, which involves the application of

	theories and methods of physics and engineering and is characterized by complexity and uncertainty of conditions. *Theoretical content of the subject area:* basic concepts of the theory of electric and electromagnetic circuits, modeling, optimization and analysis of modes of operation of power plants, networks and systems, electric machines, electric drives, electrotechnical and electromechanical systems and complexes using traditional and renewable energy sources. *Methods, techniques and technologies:* analytical methods calculation of electrical circuits, power supply systems, electrical machines and devices, control systems for electrical and electromechanical systems, electrical loads using specialized laboratory equipment, personal computers and other equipment. *Tools and equipment:* measuring instruments, electrical and electronic devices, microcontrollers, computers.
Orientation of EP	Educational and professional
The main focus of the EP	Special education in the field of power engineering, electrical engineering and electromechanics. The program is based on well-known scientific principles, taking into account the current state of development of the power and electromechanical industries, focuses on current areas in which further professional and scientific career is possible: development of industrial automation systems; development and implementation of electromechanical automatic control systems; development of electric vehicle control systems. Keywords: electricity, electric power, electrical engineering, electromechanics, automation, electric drive, electric mobility
Features of EP	- declared the possibility of training foreign students at the Center for International Education Igor Sikorsky KPI; - the possibility of teaching certain educational components in English; - conducting internships for students in the industry.
4 - Suitability of graduates for employment and further study	
Suitability for employment	Graduates are able to hold positions, the qualification requirements of which provide for a bachelor's degree in electrical engineering, electrical engineering and electromechanics, in the subjects farms engaged in such economic activities (by CEA-2010): 27.1 Manufacture of electric motors, generators, transformers, electrical distribution and control equipment; 27.2 Manufacture of batteries and accumulators; 27.3 Manufacture of wires, cables and electrical devices; 27.4 Manufacture of electric lighting equipment; 27.5 Manufacture of household appliances;

	27.9 Manufacture of other electrical equipment; 33.14 Repair and maintenance of electrical equipment; 33.20 Installation and assembly of machines and equipment; 35.11 Electricity generation; 35.12 Transmission of electricity; 35.13 Distribution of electricity; 35.14 Electricity trade; 42.22 Construction of electricity and telecommunications facilities; 43.21 Electrical work. Graduates can be employed in positions (according to the current Classifier of Professions of Ukraine SC 003:2010).
Further training	Possibility to continue studying at the second (master's) level of higher education. Acquisition of additional qualifications in the system of postgraduate education, advanced training.
5 - Teaching and assessment	
Teaching and learning	Lectures, practical and seminar classes, computer workshops and laboratory works; technology of blended learning, practice; execution of the dissertation
Evaluation	Rating system, assessment, oral and written exams, testing
6 - Program competencies	
Integral competence	Ability to solve specialized problems and solve practical problems during professional activities in the field of power engineering, electrical engineering and electromechanics or in the learning process, which involves the application of theories and methods of physics and engineering and are characterized by complexity and uncertainty.
General Competences (GC)	C01. Ability to abstract thinking, analysis and synthesis. C02. Ability to apply knowledge in practice situations. C03. Ability to communicate in the state language both orally and in writing. C04. Ability to communicate in a foreign language. C05. Ability to search, process and analyze information from various sources. C06. Ability to identify, pose and solve problems. C07. Ability to work in a team. C08. Ability to work autonomously. C09. The ability to exercise their rights and responsibilities as a member of society, to realize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine. C10. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on

	understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies. active recreation and a healthy lifestyle.
Professional competencies (PC)	C11. Ability to solve practical problems using computer-aided design and calculation systems (CADCS). C12. Ability to solve practical problems involving methods of mathematics, physics and electrical engineering. C13. Ability to solve complex specialized problems and practical problems related to the operation of electrical systems and networks, the electrical part of stations and substations and high voltage equipment. C14. Ability to solve complex specialized problems and practical problems related to the problems of metrology, electrical measurements, operation of automatic control devices, relay protection and automation. C15. Ability to solve complex specialized problems and practical problems related to the operation of electric machines, devices and automated electric drive. C16. Ability to solve complex specialized problems and practical problems related to the problems of production, transmission and distribution of electricity. C17. Ability to develop projects of electric power, electrotechnical and electromechanical equipment with observance of requirements of the legislation, standards and technical task. C18. Ability to perform professional duties in compliance with the requirements of safety, labor protection, industrial sanitation and environmental protection. C19. Awareness of the need to increase the efficiency of electrical, electrical and electromechanical equipment. C20. Awareness of the need to constantly expand their knowledge of new technologies in power engineering, electrical engineering and electromechanics. C21. Ability to promptly take effective measures in emergency situations in power and electromechanical systems. C22. Ability to use the methods of automatic control theory in the study of linear and nonlinear systems for stability, to analyze the quality of transients, to synthesize P, PD, PI and PID controllers, to compile and analyze structural diagrams of automatic control systems. C23. Ability to use the MatLab modeling software package for modeling, synthesis and analysis of electromechanical automation systems and electric drives. C24. Ability to use typical electronic components for assembling circuits of inverters, converters, rectifiers, to understand the principles of operation of power converters, to perform calculations of electronic circuit

	elements. C25. Ability to perform calculations of the mechanical part of the electric drive, mechanical transients, calculate the parameters of DC and AC motors, perform their modeling and analysis. C26. Ability to apply the laws of algebra-logic and Carnot maps to minimize logical expressions, use transition tables, graph transitions and cyclograms to synthesize logical equations describing the operation of discrete automation schemes. C27. Ability to apply methods of synthesis of discrete automation circuits for compiling programs for programmable logic relays and programmable logic integrated circuits, to select equipment for designing discrete automation systems, to connect input and output signals to PLC and PLD, to compose logic circuits using modern element base .

7 - Program learning outcomes

LO01. Know and understand the principles of electrical systems and networks, power equipment of power plants and substations, protective earthing and lightning protection devices and be able to use them to solve practical problems in professional activities.
LO02. Know and understand the theoretical foundations of metrology and electrical measurements, the principles of automatic control devices, relay protection and automation, have the skills to perform appropriate measurements and use these devices to solve professional problems.
LO03. Know the principles of operation of electric machines, devices and automated electric drives and be able to use them to solve practical problems in professional activities.
LO04. Know the principles of operation of bioenergy, wind, hydro and solar power plants.
LO05. Know the basics of the theory of the electromagnetic field, methods of calculating electric circuits and be able to use them to solve practical problems in professional activities.
LO06. Use application software, microcontrollers and microprocessor technology to solve practical problems in professional activities.
LO07. Carry out analysis of processes in electrical, electrical and electromechanical equipment, relevant complexes and systems.
LO08. Select and apply suitable methods for analysis and synthesis of electromechanical and electrical systems with specified parameters.
LO09. Be able to evaluate the energy efficiency and reliability of electrical, electrical and electromechanical systems.
LO10. Find the necessary information in the scientific and technical literature, databases and other sources of information, assess its relevance and reliability.
LO11. To communicate freely on professional problems in the state and foreign languages orally and in writing, to discuss the results of professional activity with specialists and non-specialists, to argue their position on debatable issues.
LO12. Understand the basic principles and objectives of technical and environmental safety of electrical and electromechanical objects, take them into account when making decisions.
LO13. Understand the importance of traditional and renewable energy for successful economic development of the country.
LO14. Understand the principles of European democracy and respect for the rights of citizens, take them into account in decision-making.
LO15. Understand and demonstrate good professional, social and emotional behavior, follow a healthy lifestyle.

LO16. Know the requirements of regulations relating to engineering, protection of intellectual property, labor protection, safety and industrial sanitation, take them into account when making decisions. LO17. Solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power plants, substations, systems and networks. LO18. Be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software. LO19. Apply suitable empirical and theoretical methods to reduce electricity losses during its production, transportation, distribution and use. LO20. Know and understand the principles of control of linear, nonlinear and discrete automatic control systems; mathematical methods in electromechanics. LO21. Know and understand the basics of microprocessor technology, typical structures of microcontrollers and data transmission. LO22. Know and understand the principles of operation of power converters to control DC and AC drives. LO23. Know and understand the basics of coordinate transformation and principles of frequency and vector control of electromechanical systems. LO24. Be able to apply the laws of algebra-logic, code transformation, Carnot maps, basis of transition tables, graph transitions, cyclograms and multiplexers-selectors for the synthesis of logic control circuits of automation systems. LO25. Know the principles of operation of programmable logic relays and programmable logic integrated circuits; basics of designing electrical circuit diagrams using a discrete element base. LO26. Know ways to increase the efficiency of control algorithms for electric drives, electromechanical systems, the basics of the theory of electromobility. LO27. Know and understand the laws of transformation of structural schemes, typical control laws, methods of studying the stability of linear automatic control systems; typical libraries of Simulink blocks, basics of programming in M-files. LO28. Know the equations of motion of the electric drive for different variants of masses; methods of calculating the mechanical part of the electric drive; ways to control DC and AC motors; methods for selecting electric motors by power. LO29. Develop design and engineering documentation for control circuits of electromechanical systems; to program microprocessors, microcontrollers, programmable logic integrated circuits and logic controllers and use them to implement control algorithms for electric drives.

8 - Resource support for program implementation	
Staffing	In accordance with the personnel requirements for ensuring the implementation of educational activities for the relevant level of HE, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 №1187 (current) in the wording dated 23.05.2018 №347.
Logistics	In accordance with the technological requirements for material and technical support of educational activities of the appropriate level of HE (Annex 4 to the License Conditions), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187
Information and educational and methodical support	In accordance with the technological requirements for educational and methodological and informational support of educational activities of the appropriate level of HE (Annex 5 to the Licensing Conditions), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187

9 - Academic mobility	
National credit mobility	Possibility of concluding agreements on academic mobility, double graduation, etc.
International credit mobility	Possibility to conclude agreements on international academic mobility, on double graduation, on long-term international projects that include inclusive student education, etc. International projects: **Project Erasmus+ (KD1)** with West Pomeranian University of Technology, Szczecin, Poland (West Pomeranian University of Technology in Szczecin) **Project DAAD** with the Higher Technical School of Hesse - University of Applied Sciences, Hesse, Germany (Technische Hochschule Mittelhessen - University of Applied Sciences) **Project Erasmus+ (KD1)** with the University of Lorraine, Min Nancy High School, Nancy, France (Universite de Lorraine Ecole Nationale Superieur des Mines Nancy, ville Nancy, France) **Project Erasmus+ (KD1)** with Le Mans University, Le Mans, France (Université du Maine, ville Le Mans, France) **Project Erasmus+ (KD1)** with the University of Applied Sciences in Giessen, Germany (Technische Hochschule Mittelhessen)
Training of foreign applicants HE	Teaching in English

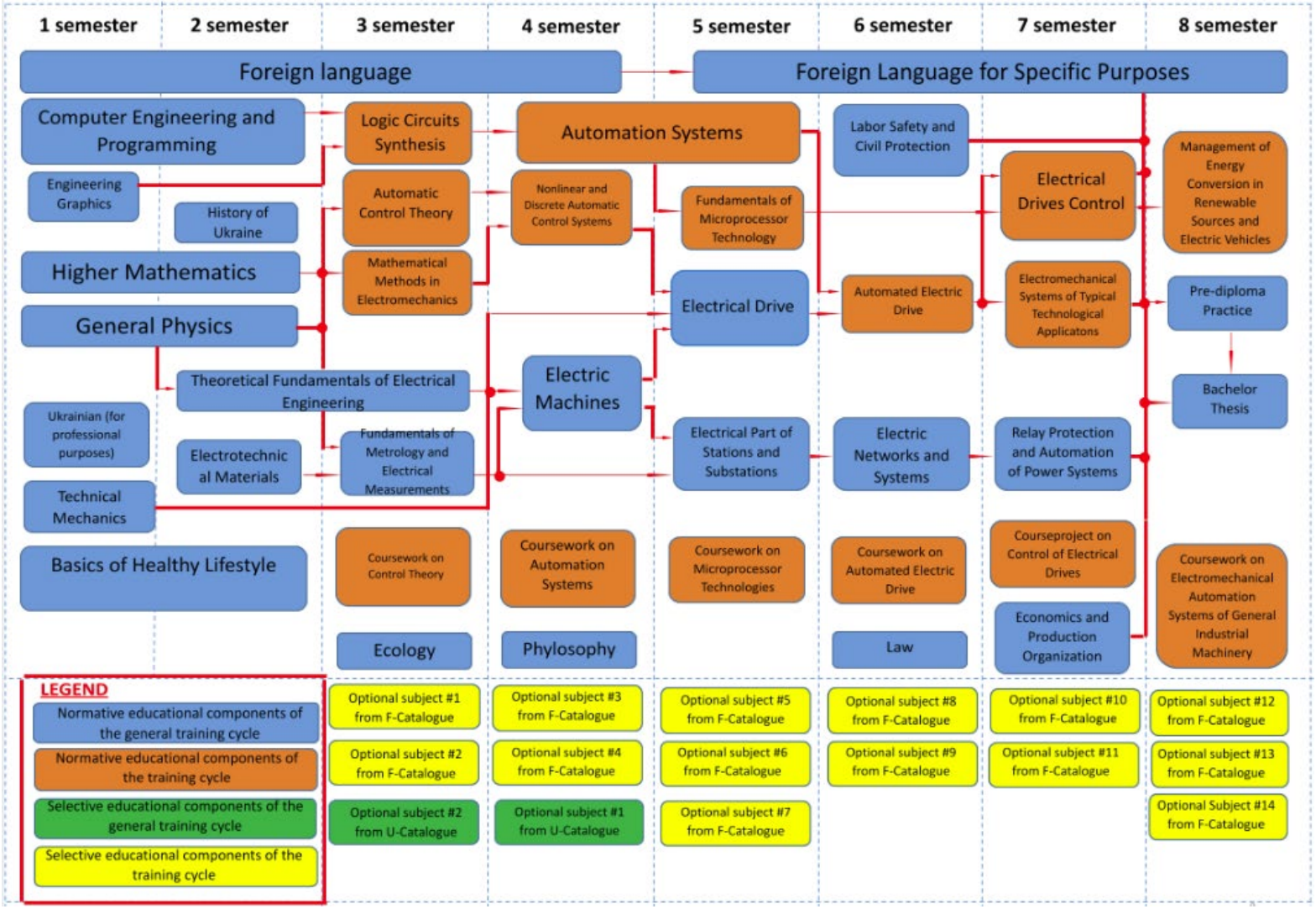
2. LIST OF COMPONENTS OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM

Code	Components of the educational program (academic disciplines, term papers, term projects, practices, qualification work)	Number of credits	Form of final control
1	**2**	**3**	**4**
NORMATIVE components of the EP			
General training cycle			
ZO 1	Ukrainian Language for Professional Purposes	2,0	Credit
ZO 2	History of Ukraine	2,0	Credit
ZO 3	Physical Education	5,0	Credit
ZO 4	Foreign Language	6,0	Credit
ZO 5	Economics and Production Organization	3,0	Credit
ZO 6	Fundamentals of Labor Safety and Civil Defence	4,0	Credit

ZO 7	Higher Mathematics	18,0	Exam
ZO 8	General Physics	9,0	Exam
ZO 9	Computing and Programming	12,0	Credit
ZO 10	Engineering Graphics	3,0	Credit
ZO 11	Technical Mechanics	3,0	Credit
ZO 12	Electrotechnical Materials	3,0	Credit
ZO 13	Fundamentals of Metrology and Electrical Measurements	4,0	Exam
ZO 14	Theoretical Fundamentals of Electrical Engineering	10,0	Exam
ZO 15	Electric Machines	6,0	Exam
ZO 16	Electrical Equipment of Electric Power Stations and Substations	4,0	Exam
ZO 17	Electrical Drive	4,0	Exam
ZO 18	Electrical Systems and Networks	6,0	Exam
ZO 19	Relay Protection and Automation of Power Systems	4,0	Credit
Vocational training cycle			
PO 1	Control Theory	6,0	Credit
PO 2	Logic Circuits Synthesis	3,0	Credit
PO 3	Modeling and Analysis of Electromechanical Systems in MATLAB	3,5	Exam
PO 4	Automation Systems	11	Exam
PO 5	Microprocessor Technologies	3	Credit
PO 6	Electrical Drives Theory	5,5	Exam
PO 7	Control of Electrical Drives	10	Exam
PO 8	Industrial Electromechanical Systems	8	Credit
PO 9	Energy conversion control in green technologies and electric vehicles	3,5	Exam
PO 10	Coursework on Control Theory	1	Credit
PO 11	Coursework on Automation Systems	1	Credit
PO 12	Coursework on Microprocessor Technologies	1	Credit
PO 13	Coursework on Electrical Drives Theory	1	Credit
PO 14	Courseproject on Control of Electrical Drives	1	Credit
PO 15	Coursework on Industrial Electromechanical Systems	1	Credit
PO 16	Pre-diploma Practice	6	Credit
PO 17	Diploma Project	6	Credit
ELECTIVE educational components			
General training cycle			
ZV 1	Optional subject #1 from U-Catalogue	2,0	Credit

ZV 2	Optional subject #2 from U-Catalogue	2,0	Credit
ZV 3	Optional subject #3 from U-Catalogue	2,0	Credit
ZV 4	Optional subject #4 from U-Catalogue	2,0	Credit
ZV 5	Іноземна мова професійного спрямування	6,0	Exam
Vocational training cycle			
PV 1	Optional subject #1 from F-Catalogue	4,0	Credit
PV 2	Optional subject #2 from F-Catalogue	2,5	Credit
PV 3	Optional subject #3 from F-Catalogue	5,0	Credit
PV 4	Optional subject #4 from F-Catalogue	2,0	Exam
PV 5	Optional subject #5 from F-Catalogue	4,5	Exam
PV 6	Optional subject #6 from F-Catalogue	3,0	Credit
PV 7	Optional subject #7 from F-Catalogue	3,0	Credit
PV 8	Optional subject #8 from F-Catalogue	3,0	Exam
PV 9	Optional subject #9 from F-Catalogue	5,0	Credit
PV 10	Optional subject #10 from F-Catalogue	4,0	Credit
PV 11	Optional subject #11 from F-Catalogue	4,0	Credit
PV 12	Optional subject #12 from F-Catalogue	5,0	Exam
TOTAL of NORMATIVE educational components		180 credits	
TOTAL of ELECTIVE educational components		60 credits	
The scope of educational components that ensure the acquisition of competencies of certain SHE:		120 credits	
TOTAL		**240 credits**	

3. STRUCTURAL AND LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM



4. FORM OF GRADUATE CERTIFICATION OF HIGHER EDUCATION APPLICANTS

Graduation certification of applicants for higher education under the educational-professional program "Electromechanical automation systems, electric drive and electric mobility" specialty 141 "Electric power, electrical engineering and electromechanics" is carried out in the form of defense of qualifying work and ends with the issuance of a standard document in power engineering, electrical engineering and electromechanics.

The qualification work is checked for the absence of academic plagiarism, fabrication and falsification and after the defense is placed in the repository of the STL of the University for free access. Graduation certification is carried out openly and publicly.

5. MATRIX OF COMPLIANCE OF SOFTWARE COMPETENCIES WITH COMPONENTS OF THE EDUCATIONAL PROGRAM

	ZO1	ZO2	ZO3	ZO4	ZO5	ZO6	ZO7	ZO8	ZO9	ZO10	ZO11	ZO12	ZO13	ZO14	ZO15	ZO16	ZO17	ZO18	ZO19	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16	PO17
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K27																					+		+							+					

6. MATRIX OF PROVIDING SOFTWARE LEARNING RESULTS BY RELEVANT COMPONENTS OF THE EDUCATIONAL PROGRAM

	ZO 1	ZO 2	ZO 3	ZO 4	ZO 5	ZO 6	ZO 7	ZO 8	ZO 9	ZO 10	ZO 11	ZO 12	ZO 13	ZO 14	ZO 15	ZO 16	ZO 17	ZO 18	ZO 19	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PO 16	PO 17
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RC20																				+		+				+			+						
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RC24																					+		+							+					
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RC26																										+		+				+			
RC27																				+		+							+					+	+
RC28																		+							+							+			
RC29																							+	+		+		+						+	+