MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

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

Seal of the University

APPROVED
Academic Council of "Igor Sikorsky Kyiv Polytechnic Institute"

Protocol № 3 from 15.03.2021

Head of Academic Council

_____ **Mykhaylo Ilchenko**
(Signature)

ELECTRICAL POWER DISTRIBUTION SYSTEMS ENGINEERING

EDUCATIONAL AND PROFESSIONAL PROGRAM

The second (master's) level of higher education

Speciality	**141 - Electric Power Engineering, Electrical Engineering and Electromechanics**
Field of knowledge	**14 - Electrical Engineering**
Qualification	**Master of Electrical Power Engineering, Electrical Engineering and Electromechanics**

Put into effect by order of the rector of
Igor Sikorsky Kyiv Polytechnic Institute
(Decree № NON/89/2021 from 19.04.2021)

Kyiv - 2021

PREFACE

Developed by a working group:

Chairman of the working group:
Fedosenko Mykola, Candidate of Technical Sciences (Ph.D.),
Associate Professor of the Department of of Electric Power Supply Systems
Members of the working group:
Zamulko Anatolii, Candidate of Technical Sciences (Ph.D.),
Associate Professor of the Department of of Electric Power Supply Systems
Yarmoliuk Olena, Candidate of Technical Sciences (Ph.D.),
Associate Professor of the Department of of Electric Power Supply Systems

The Department of Electric Power Supply Systems is responsible for the preparing of applicants for higher education under the educational program

Agreed:

Scientific and Methodological Commission of
Igor Sikorsky Kyiv Polytechnic Institute
by specialty 141 - Electric Power Engineering,
Electrical Engineering and Electromechanics

Head of the Commission
Yandulskyi Oleksandr _____

(Signature)

Protocol № 3 from 18.02.2021

Methodological Counsil of
Igor Sikorsky Kyiv Polytechnic Institute

Head of the Counsil
Yakymenko Yurii _____

(Signature)

Protocol № 6 from 25.02.2021

According to the results of monitoring the educational and professional program "Electrical power distribution systems engineering" of the second (master's) level of higher education in the specialty 141 Electrical power engineering, electrical engineering and electromechanics, approved by the decision of the Academic Council from 02.04.2018, protocol № 4, taking into account the proposals of the members of the educational process, which are involved in the implementation of the educational program, the proposals of graduates, employers and other external stakeholders, it was updated.

The project team reviewed the balance, rational use of credits, the ability of students to master certain disciplines (educational components) and the entire educational program, to keep within the certain time, the completeness of documentary, staffing, information, other forms of the educational program support and compliance of the educational program with the License Conditions.

To ensure the possibility of forming an individual educational trajectory, including the individual choice of academic disciplines in the amount provided by law, it was decided to replace the existing sample units by the separate educational components.

The educational and professional program "Electrical power distribution systems engineering" was discussed and approved by teaching staff of the Department of Electric Power Supply Systems (Protocol № 9 from 19.01.2021).

CONTENT

1. PROFILE OF THE EDUCATIONAL PROGRAM

in specialty 141- Electric Power Engineering, Electrical Engineering and Electromechanics

1 – General information	
Full name of the Higher Education Institution and Institute /Faculty	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Institute of Energy Saving and Energy Management
Higher education degree and the name of the qualification in the language of the original	Degree – Master Qualification – Master of Electric Power Engineering, Electrical Engineering and Electromechanics
Official name of Educational Program	Electrical power distribution systems engineering
Type of diploma and volume of Educational Program	Master's degree, unitary, 90 credits, term of study 1 year and 4 months
Availability of accreditation	Certificate of Accreditation series НД-ІІ № 1157241, issued by the Ministry of Education and Science of Ukraine Period of accreditation from April 30, 2013 to July 01, 2023
Cycle/level of higher education	NQF of Ukraine – 7-th level QF-EHEA – second cycle EQF-LLL – 7-th level
Prerequisites	Availability of a Bachelor's degree
The duration of the Educational Program	To the next accreditation
Internet address of the permanent placement of the Educational Program	http://ep.kpi.ua/ department website https://osvita.kpi.ua/ section "Educational programs"
2 – The purpose of the Educational Program	
The purpose of the educational program is to train professionals capable of solving complex problems in the field of electricity supply, energy security of society and the state, comprehensive professional, intellectual, social and creative development of the individual at the highest levels of excellence in the educational and scientific environment. To this end, the educational program provides: 1. Fundamental training of specialists in mathematics, physics, economics, philosophy of nature and society; 2. Harmonized specialized training of specialists in the field of power engineering, electrical engineering and electromechanics, from classical theoretical foundations of electrical engineering to modern high-efficiency systems of production, transmission and distribution of electricity using information and computer systems and systems of analysis and control of power supply systems. use and provision of consumers with electricity; 3. Specialized harmonized training in the field of mathematical modeling and optimization of power supply modes, development of information and software systems for metering and distribution of electricity, integrated use of traditional and renewable energy sources in modern electricity markets; 4. Harmonized interdisciplinary organizational-economic and regulatory training of specialists capable of creating new startups and successfully competing in high-tech labor markets;	

5. Interdisciplinary pedagogical and psychological training of specialists for further self-development, basic training and life-long learning skills; harmony, multidimensionality of education; integration of scientific-innovative and practical activity and educational process; focus on international requirements in the industry; focus on labor market requirements and dual education	
3 – Characteristics of the Educational Program.	
Subject area	**Object**: scientific institutions and organizations in the field of electric power engineering, electrical engineering and electromechanics, enterprises of the electric power complex, electric power and electromechanical companies. **Subject**: processes of generation, transmission, distribution and consumption of electrical energy at power plants, power grids and systems; processes of conversion of electrical energy in electromechanical systems; safety analysis, reliability improvement and increase of service life of electric power, electrotechnical and electromechanical equipment. **The purpose of education**: training of specialists capable to design, operate, ensure a safety culture, perform installation, repair, creating new equipment and implementing the latest technologies, conducting research and teaching activity. **Theoretical content of the subject area:** fundamental knowledge of the theory of electrical engineering, modeling and optimization of electric power, electrotechnical and electromechanical systems and complexes, their use for innovations and researches of power stations, networks and systems, electric machines and electric drives modes of operation. **Methods, methodics and technologies:** methods and means of research of processes in the equipment of electric power and electromechanical systems and complexes, automated design and manufacturing systems. **Tools and equipment**: tools, devices, systems, technologies of design, operation, control, monitoring.
Orientation of the Educational Program	Educational-professional
The main focus of the Educational Program	General education in the field of Electric Power Engineering, Electrical Engineering and Electromechanics. The main focuses of the program are: 1. Enhanced training in the construction and management of modern electricity distribution systems; 2. Enhanced training in the field of mathematical modeling and optimal decision making in power supply systems; 3. Fundamental training in the theory of research of complex systems, the class of which includes systems of providing consumers with electricity, monitoring of power facilities and systems; 4. Enhanced training in the theory of implementation of dispersed renewable energy systems, energy storage systems and their management; 5. Enhanced training on the introduction and functioning of electricity markets and regulation in the energy sector, management of production and consumption of electricity in market conditions;

	6. Intensified training in the field of intellectualization of electric power networks, information technologies, introduction of energy efficient Smart Grid technologies; 7. Enhanced training in the use of power electronics systems, relay protection and controls in the power industry; 8. Enhanced training in the field of regulatory and legal support in the power industry; 9. Work plans for the training of applicants for higher education are reviewed annually to include sections related to the development of knowledge in the power industry based on the analysis of new scientific and technological achievements; 10. Development of dual education and interuniversity programs with the world's leading institutions, participation in international conferences; 11. Conducting annual conferences and competitions on innovations in the energy sector in order to train applicants for higher education to develop individual startups at the stage of preparation of qualifying work. Keywords: electricity, electricity distribution systems, mathematical modeling, energy efficiency, electricity consumers, reliability of electricity supply, electricity losses, electricity quality, optimization, distributed generation, electricity market, Smart Grid technologies.
Features of the Program	- involvement of specialists from other educational institutions in teaching academic disciplines; - conducting internships for students in the industry; - participation applicants in student scientific circles; possibility to teach separate courses in English. 1. Enhanced training in the use of mathematical methods, information technology, advances in power electronics in the construction of modern power distribution systems; 2. Ability to design and manage modes of electricity supply systems in the context of modern world trends associated with the widespread involvement in their structure of dispersed means of generating and accumulating energy, which fundamentally distinguishes them from existing ones; 3. The use of dual education, the possibility of obtaining a double master's degree in electrical engineering, electrical engineering and electromechanics, a wide exchange of students with universities of the European Union internships in leading organizations in the energy sector of Ukraine; 4. Knowledge of market mechanisms, specifics of construction and operation of energy markets.
4 – Eligibility of graduates for employment and further education	
Suitability for employment	According to the occupational classifier ДК003:2010 graduates can perform the following types of professional activity: 3113 Power substation manager 3113 Dispatcher of the district (local) dispatching point 3113 Power engineer of production 3113 Power engineer of the shop 3113 Energetic

	3113 Power engineer of production 3113 Power engineer of a site 3113 Power engineer of the shop 3113 Energy Dispatcher Professional certification is possible.
Further training	Continuation of education at the third (educational and scientific) level of higher education and / or acquisition of additional qualifications in the system of adult education.
5 – Teaching and evaluation	
Teaching and learning	Lectures, practical classes and seminars, computer classes and laboratory work; course projects and course works; technology of mixed learning, practice and excursions; implementation of the master's thesis.
Evaluation	According to the rating system, oral and written exams, tests.
6 – Program competencies	
Integral competence	Ability to solve complex problems during professional activities in the field of electric power engineering, electrical engineering and electromechanics or in the process of training, which involves conducting researches and / or innovations implementation and is characterized by uncertainty of conditions and requirements.
General competencies (GC)	
GC 1	Ability to abstract thinking, analysis and synthesis
GC 2	Ability to search, process and analyze information from various sources
GC 3	Ability to use information and communication technologies
GC 4	Ability to apply knowledge in practical situations
GC 5	Ability to use a foreign language in scientific and technical activities
GC 6	Ability to make informed decisions
GC 7	Ability to learn and to acquire modern knowledge
GC 8	Ability to detect and assess risks
GC 9	Ability to work autonomously and in a team
GC10	Ability to detect feedback and adjust their actions with their consideration
Professional competencies (PC)	
PC1	Ability to apply the obtained theoretical knowledge, scientific and technical methods for solving scientific and technical problems and problems of Electric Power Engineering, Electrical Engineering and Electromechanics
PC 2	Ability to apply existing and develop new methods, techniques, technologies and procedures for solving engineering problems of Electric Power Engineering, Electrical Engineering and Electromechanics
PC3	Ability to plan, organize and carry out scientific research in the field of Electric Power Engineering, Electrical Engineering and Electromechanics
PC4	Ability to develop and implement measures to improve the reliability, efficiency and safety in the process of design and operation of equipment and facilities of Electric Power Engineering, Electrical Engineering and Electromechanics systems
PC5	Ability to analyze technical and economic indicators and to carry out examination of design solutions in the field of Electric Power Engineering, Electrical Engineering and Electromechanics
PC6	Ability to demonstrate knowledge and understanding of mathematical principles and methods necessary for use in Electric Power Engineering, Electrical Engineering and

	Electromechanics
PC7	Ability to demonstrate awareness in issues of intellectual property and contracts in Electric Power Engineering, Electrical Engineering and Electromechanics
PC8	Ability to investigate and define the problem and identify constraints, including those related to environmental protection, sustainable development, health and safety, and risk assessments in Electric Power Engineering, Electrical Engineering and Electromechanics
PC9	Ability to understand and take into account social, environmental, ethical, economic and commercial considerations that influence the implementation of technical solutions in Electric Power Engineering, Electrical Engineering and Electromechanics
PC10	Ability to manage projects and evaluate their results
PC11	Ability to assess the reliability and efficiency of objects and systems in Electrical Power Engineering, Electrical Engineering and Electromechanics
PC12	Ability to develop plans and projects to achieve the stated goal, taking into account all aspects of the problem, including the production, operation, maintenance and utilization of electrical power, electrical engineering and electromechanical equipment
PC13	Ability to demonstrate awareness and ability to use regulatory acts, norms, rules and standards in Electric Power Engineering, Electrical Engineering and Electromechanics
PC14	Ability to use methods for evaluating intellectual property rights of objects for their further commercialization, including the sale of licenses and technology transfer
PC15	Ability to publish the results of researches in scientific professional editions
PC 16	Willingness to formulate and prepare technical tasks for the making design solutions for individual elements of electrical distribution systems using the current regulatory framework, modern means of design automation based on advanced information technologies, taking into account international experience
PC 17	Ability to develop methodical and normative documents, proposals and realize implementation of developed projects and programs, to carry out examination of technical documentation
PC 18	Ability to perform technical calculations to solve problems of design, development and control of electrical distribution systems modes and the effective operation of electrical distribution networks
PC 19	Ability to carry out feasibility studies of design solutions for the implementation of innovative technologies for solvsng engineering problems. Possession of the basics of design, reconstruction and operation of electrical power distribution systems of industrial and municipal facilities, development of relevant design and engineering documentation.
PC 20	Ability to make decisions on the optimal distribution of electrical energy to consumers at all levels of the electric power sector, taking into account energy efficiency and environmental factors, minimizing the level of electrical energy losses, ensuring the reliability and quality of electric power supply. Willingness to develop and implement energy and resource saving measures in the design and operation of electrical distribution systems.
PC 21	Ability to use knowledge in the field of electric power for mathematical modeling of

	electric power objects, systems and their processes, to estimate indicators of efficiency of electric power distribution systems operation
7 – Program learning outcomes	
KNOWLEDGE (KN)	
KN 1	Main types of intellectual rights and ways of their protection, methodological and legislative foundations for the creation of objects of intellectual property
KN 2	The main clauses of normative and legislative documents that regulate innovation activity in Ukraine
KN 3	The list of the main open international banks of electronic resources to support the education, research and innovation activities
KN 4	Basic principles of sustainable development of society taking into account social technological, economic and environmental aspects of human activity
KN 5	Foreign language at a level that ensures free discussion with foreign scientists on the topics of actual scientific and technical problems of Electric Power Engineering, Electrical Engineering and Electromechanics and the opportunity to submit scientific reports at international conferences and symposiums.
KN 6	Current standards, regulatory acts and regulations, according to which activities in the field of Electrical Power Engineering, Electrical Engineering and Electromechanics are carried out in Ukraine
KN 7	Rules of safe operation of electrical power, electrotechnical and electromechanical equipment
KN 8	The clauses of the Energy Strategy of Ukraine and the principles of energy security
KN 9	Effective methods and approaches aimed to increasing energy efficiency and reliability of electrical power, electrotechnical and electromechanical equipment and related complexes and systems
KN 10	The newest approaches and modern methods of conducting scientific research in the field of Electrical Power Engineering, Electrical Engineering and Electromechanics
KN 11	Modern methods of mathematical modeling of objects and processes in electrical power, electrotechnical and electromechanical systems
KN 12	Modern software complexes designed to create computer models of objects and in-depth study of processes in electrical power, electrotechnical and electromechanical systems
KN 13	Theories of large systems, system analysis and mathematical methods that are used to solve optimization problems in the field of electrical power systems
KN 14	Approaches to optimal planning and conducting experiments, methods of processing and evaluation of experimental research results using modern information technologies, current norms and requirements for the execution of reports of researches
KN 15	Composition and sequence of developing innovative projects
KN 16	Analytical methods for determining and numerical methods for calculating processes parameters in electrical power, electrotechnical and electromechanical equipment, its complexes and systems
KN 17	Principles of effective management of manufacturing and research activities with the implementation of innovative approaches and technologies
KN 18	Legislative and regulatory framework, which determines the implementation of

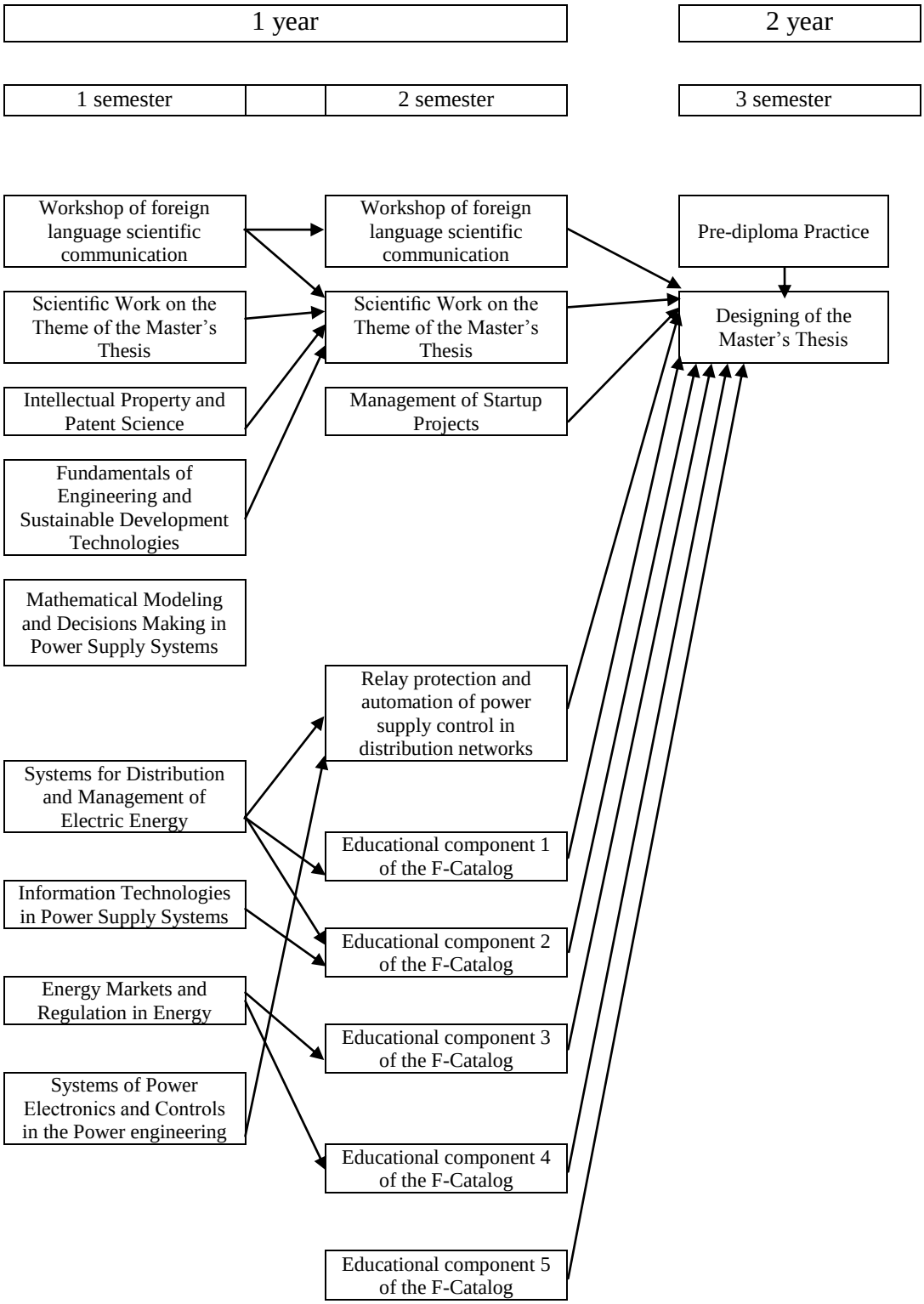
	activities in the field of electrical power, methodology and techniques, classical and innovative technologies
KN 19	Methods of selection and justification of the application of effective constructions, schemes and selection of parameters of elements of electric power objects and systems.
SKILLS (SK)	
SK 1	To find variants to increase of energy efficiency and reliability of electrical power, electrotechnical and electromechanical equipment and corresponding complexes and systems
SK 2	Reproduce processes in electrical power, electrotechnical and electromechanical systems in the process of their computer simulation
SK 3	Mastering new versions or new software designed for computer simulation of objects and processes in electrical power, electrotechnical and electromechanical systems
SK 4	To outline the plan of actions to increase the reliability, safety of operation and prolongation of the resource of electrical power, electrical engineering and electromechanical equipment and related complexes and systems
SK 5	To analyze processes in electrical power, electrotechnical and electromechanical equipment and related complexes and systems
SK 6	To reconstruct existing electricity networks, stations and substations, electrical and electromechanical complexes and systems in order to increase their reliability, efficiency of operation and prolongation of the resource
SK 7	To take into account the legal and economic aspects of researches and innovations
SK 8	To present research materials at international scientific conferences and seminars devoted to modern problems in the field of electric power engineering, electrical engineering and electromechanics
SK 9	To justify the choice of the direction and methods of scientific research taking into account the current problems in the field of electric power engineering, electrical engineering and electromechanics
SK 10	Planning and performing scientific researches and innovation projects in the field of electric power engineering, electrical engineering and electromechanics
SK 11	Combine various forms of research and practical activity to overcome the gap between theory and practice, scientific achievements and their practical implementation
SK 12	Communicate fluently verbally and in writing in state and a foreign languages on modern scientific and technical problems of electrical power engineering, electrical engineering and electromechanics
SK 13	Identify problems and constraints related to environmental protection, sustainable development, human health and safety, and risk assessments in the field of electrical power engineering, electrical engineering and electromechanics
SK 14	Identify the main factors and technical problems that may interfere with the implementation of modern methods of control of electrical power engineering, electrical engineering and electromechanics systems
SK 15	Identify the problems facing society and that can be solved by using and adhering to the principles of sustainable development of society
SK 16	Choose methods of mathematical and physical modeling of objects and processes of

	electrical power engineering, electrical engineering and electromechanics systems
SK 17	To apply basic knowledge of basic sciences and professional disciplines, draw up schemes for providing electricity to facilities, buildings, technological complexes and individual equipment.
SK 18	To apply the main methods of analysis of reliability and efficiency of electric power facilities and systems, select and compare the efficiency of energy supply of consumers using traditional and renewable energy sources.
SK 19	To use knowledge in the field of relay protection, automation, digital systems of measurements of parameters of modes of operation in electric power distribution systems for a choice, implementation and operation of the modern corresponding equipment.
SK 20	To conduct marketing analysis of processes occurring in energy markets and form proposals for the development of new services and goods for the energy market
8 – Resource support for the implementation of the program	
Personnel support	In accordance with the personnel requirements to ensure the conduct of educational activities for the corresponding level of higher education (Appendix 2 to the License Terms), approved by a resolution of the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (according to the text of the resolution of the Cabinet of Ministers of Ukraine, May 10, 2018 № 347)
Material and technical support	In accordance with the technological requirements for the material and technical support of the educational activities of the corresponding level of higher education (Appendix 4 to the Licensing Terms), approved by the resolution of the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (according to the text of the resolution of the Cabinet of Ministers of Ukraine, May 10, 2018 № 347) Use of equipment: class rooms with multimedia projectors, computer equipment with appropriate software, laboratory equipment for educational (teaching, research, scientific) activities.
Informational educational and methodological support	In accordance with the technological requirements for educational, methodological and informational provision of educational activities of the corresponding level of higher education (Appendix 5 to the Licensing Terms), approved by the resolution of the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (according to the text of the resolution of the Cabinet of Ministers of Ukraine , May 10, 2018 № 347)/ Use of the Scientific and Technical Library of "Igor Sikorsky Kyiv Polytechnic Institute".
9 – Academic mobility	
National Credit Mobility	Ability to conclude agreements on academic mobility, double certification, etc.
International Credit Mobility	Possibility of concluding agreements on international academic mobility (Erasmus + K1), on double diploma, on long-term international projects including student studies, etc.
Teaching foreign applicants for higher education	Ability to teach in a foreign language

2. LIST OF COMPONENTS OF THE EDUCATIONAL PROGRAM

Code Discipline	Components of the educational program (academic disciplines, course projects, course works, practice, qualification work)	Amount of credits	Form of final control
1	2	3	4
1. NORMATIVE educational components			
1.1 General training cycle			
NG1	Intellectual Property and Patent Science	3,0	Test
NG2	Fundamentals of Engineering and Sustainable Development Technologies	2,0	Test
NG3	Workshop of foreign language scientific communication	3,0	Test
NG4	Management of Startup Projects	3,0	Test
1.2. Vocational training cycle			
NV1	Mathematical Modeling and Decisions Making in Power Supply Systems	4,0	Exam
NV2	Systems for Distribution and Management of Electric Energy	4,5	Exam
NV3	Course work on Systems for Distribution and Management of Electric Energy	1,0	Test
NV4	Information Technologies in Power Supply Systems	4,0	Test
NV5	Energy Markets and Regulation in Energy	4,0	Test
NV6	Systems of Power Electronics and Controls in the Power engineering	4,0	Exam
NV7	Relay protection and automation of power supply control in distribution networks	4,5	Test
Research (scientific) component			
NV8	Scientific Work on the Theme of the Master's Thesis	4,0	Test
NV9	Pre-diploma Practice	14,0	Test
NV10	Designing of the Master's Thesis	12,0	Defense
2 SELECTIVE educational components			
2.2 Professional training cycle			
EC1	Educational component 1 of the F-Catalog	5,0	Exam
EC2	Educational component 2 of the F-Catalog	5,0	Exam
EC3	Educational component 3 of the F-Catalog	4,0	Test
EC4	Educational component 4 of the F-Catalog	5,0	Exam
EC5	Educational component 5 of the F-Catalog	4,0	Test
Total of the **compulsory educational components**:		67	
Total of the **Selective educational components:**		23	
TOTAL OF THE EDUCATIONAL PROGRAM		**90**	

3. STRUCTURAL AND LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM



4. FORM OF EXECUTIVE APPROACHES OF HIGHER EDUCATION GRADUATES

Certification of applicants for higher education under the educational-professional program "Electrical power distribution systems engineering" specialty 141 "Electric Power Engineering, Electrical Engineering and Electromechanics" is carried out in the form of defense of qualifying work and ends with the issuance of a standard document on awarding a master's degree on "Electric Power Engineering, Electrical Engineering and Electromechanics" according to the educational-professional program "Electrical power distribution systems engineering",

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 "Igor Sikorsky Kyiv Polytechnic Institute" for free access.

Final certification is carried out openly and publicly.

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

	NG1	NG2	NG3	NG4	NV1	NV2	NV3	NV4	NV5	NV6	NV7	NV8	NV9	NV10
GC 1	+	+		+										
GC 2	+	+	+	+										
GC 3	+	+	+	+										
GC 4	+	+	+	+										
GC 5	+	+	+	+										
GC 6	+			+										
GC 7	+	+	+	+										
GC 8	+	+		+										
GC 9	+	+	+	+										
GC 10	+	+	+	+										
PC 1					+			+	+	+	+	+	+	+
PC 2					+	+	+			+	+	+		+
PC 3					+							+	+	+
PC 4					+	+	+			+				+
PC 5												+		+
PC 6					+	+	+				+	+		+
PC 7														+
PC 8					+						+			
PC 9					+			+	+	+	+	+		+
PC 10											+			
PC 11					+	+	+			+	+			
PC 12										+	+			+
PC 13					+			+						+
PC 14												+		
PC 15					+						+	+		+
PC 16										+				
PC 17											+			+
PC 18										+		+		+
PC 19								+		+	+			
PC 20									+					
PC 21					+						+			

6. MATRIX OF ENSURING PROGRAM RESULTS OF LEARNING BY THE CORRESPONDING COMPONENTS OF THE EDUCATIONAL PROGRAM

	NG1	NG2	NG3	NG4	NV1	NV2	NV3	NV4	NV5	NV6	NV7	NV8	NV9	NV10
KN 1	+			+										
KN 2				+	+								+	
KN 3	+	+		+							+			
KN 4		+						+						
KN 5			+										+	
KN 6		+						+			+	+	+	
KN 7											+			
KN 8		+									+			
KN 9					+	+	+	+			+			
KN 10						+	+	+			+	+		+
KN 11					+	+	+							
KN12					+					+		+	+	+
KN13					+									
KN14					+									
KN15	+		+	+										
KN16										+				
KN17		+		+		+	+					+	+	
KN18				+							+			
KN 19										+	+			
SK1					+	+	+			+	+			
SK2					+									
SK3					+					+			+	+
SK4					+					+	+			
SK5		+									+			
SK6						+	+	+		+				
SK7				+										
SK8		+	+		+						+	+		+
SK9		+			+	+	+			+	+	+	+	+
SK10				+								+		+
SK11										+				
SK12			+								+	+		
SK13		+												
SK14								+		+	+			
SK15		+		+								+		

	NG1	NG2	NG3	NG4	NV1	NV2	NV3	NV4	NV5	NV6	NV7	NV8	NV9	NV10
SK16					+					+	+			
SK17										+				
SK18								+		+	+			
SK 19						+	+							
SK 20		+				+	+		+					