

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE  
"Igor Sikorsky Kyiv Polytechnic Institute"

APPROVED

*by the Academic Council of Igor Sikorsky  
Kyiv Polytechnic Institute  
(Protocol №5 dated 17.05.2021)  
Chairman of the Academic Council  
Mychailo ILCHENKO*

**EDUCATIONAL AND SCIENTIFIC PROGRAM**  
**Nuclear Power Engineering**  
**Атомна енергетика**

**Third (educational and scientific) Level of Higher Education**

**Specialty**                      **143 Nuclear Power Engineering**

**Field of knowledge**   **14 Electrical Engineering**

**Qualification**              **Doctor of Philosophy in Nuclear Power  
Engineering**

*Put into force by order of the rector  
of Igor Sikorsky Kyiv Polytechnic Institute  
№ HOH/143/2021 dated 31.05.2021*

Igor Sikorskyy Kyiv Politechnic Institute  
Kyiv – 2021

## PREFACE

### Developed by the working group:

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Chairman of the Scientific and Methodological Commission of Igor Sikorsky Kyiv Polytechnic Institute on specialty

*Evgen Pysmenny*

Doctor of science, Professor of Department of Nuclear Power Plants and Engineering Thermal Physics, Dean of Thermal Power Faculty

### **AGREED:**

The Scientific and Methodological Commission of Igor Sikorsky Kyiv Polytechnic Institute on specialty 143 "Nuclear Power Engineering"

Chairman *Evgen Pysmenny*

(Protocol № 5 dated 12.02.2021)

The Methodological Council of Igor Sikorsky Kyiv Polytechnic Institute

Chairman *Yuriy Yakimenko*

(Protocol № 7 dated 13.05.2021)

## **Professional expertise of interested persons (stakeholders) is taken into account:**

*Vladislav Inushev*, Acting Director of State Scientific and Engineering Center for Control and Emergency Response Systems, PhD

*Olexander Pecheritsa*, Deputy Director of SSTC NRS for Scientific and International Activities, PhD.

*Volodymir Borisenko*, Head of the Department of Nuclear Energy of the Institute of NPP Safety Problems of the National Academy of Sciences of Ukraine, Doctor of Science.

Feedback-reviews of stakeholders are attached.

According to the results of monitoring the educational-professional program "Nuclear Power Plants" of the third (educational&scientific) level of higher education of the specialty 143 "Nuclear Power Engineering", approved by the Academic Council, protocol №6 dated 07.09 2020, taking into account the proposals of the educational process participants involved into educational-professional program implementation, proposals of graduates, employers and other external stakeholders, it was updated.

The peculiarities of the educational program are specified, which focuses on providing training for specialists capable of independent research, research and innovation, organizational and managerial, pedagogical activities; and also takes into account the requirements of the draft Standard of Higher Education for the third (educational and scientific) level of higher education in the specialty 143 "Nuclear Power Engineering".

The project team reviewed the balance, rational allocation of credits, the ability of higher education seekers to effectively acquire its educational components and the entire educational program, the completeness of documentary, personnel, information and other support of educational-professional program and its compliance with the licensing terms. In particular: the educational component "Industrial Practice" was added to the list of normative educational components; the volume of teaching in the block of educational components of the vocational training cycle was redistributed; the list of normative educational components of the general training cycle has been updated. To optimize the mechanism of formation of an individual educational trajectory, the approach to the formation of a catalog of elective educational components has been revised, namely: standardization of such disciplines by the number of ECTS credits has been carried out. The requirements of the Resolution of the Cabinet of Ministers of Ukraine of June 25, 2020 № 519 (new version of the "National Qualifications Framework") are taken into account.

Educational program was discussed after receiving all wishes and suggestions from stakeholders and approved at an extended meeting of the Department of Nuclear Power Plants and and Engineering Thermal Physics (Protocol №13 dated 09.02.2021).

# CONTENT

1. EDUCATIONAL PROGRAM PROFILE.....	5
2. LIST OF COMPONENTS OF THE EDUCATIONAL PROGRAM .....	10
3. STRUCTURAL AND LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM .....	11
4. SCIENTIFIC COMPONENT .....	12
5. HIGHER EDUCATION CERTIFICATION FORM .....	13
6. MATRIX OF CONFORMITY .....	14

# 1. EDUCATIONAL PROGRAM PROFILE

## of the specialty 143 “ Nuclear Power Engineering”

<b>1 – General Information</b>	
Full name of University and it`s institute / faculty	National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Faculty of Heat and Power Engineering
Degree of higher education and title of qualification in the original language	Degree of higher education – Doctor of Philosophy Educational qualification - Doctor of Philosophy on Nuclear Energy
The official name of the educational program	Educational program "Nuclear Energy" of the third (educational and scientific) level of higher education
Type of diploma and scope of educational program	Doctor of Philosophy, educational component of 50 ECTS credits, training period 4 years. The scientific component involves conducting your own research and design of its results in the form of a theses.
Availability of accreditation	Will be accredited in 2021 for the first time.
Cycle / level of Higher Education	HPK of Ukraine – 8-th level QF-EHEA - the third cycle EQF-LLL – 8-th level
Prerequisites	Availability of complete magister education
Language (s) of education	Ukrainian / English
Term of the educational program	Until the next accreditation
Internet address of the permanent placement of the educational program	<a href="http://aesitf.kpi.ua/">http://aesitf.kpi.ua/</a> / section Educational programs  <a href="https://osvita.kpi.ua/">https://osvita.kpi.ua/</a> section Educational programs
<b>2 – The Purpose of the Eductaion Program</b>	
<p>Training of highly qualified, competitive, integrated into the European and world scientific and technical space specialists of the degree of Doctor of Philosophy in Atomic Energy, capable of independent research, scientific-innovative, organizational-managerial, pedagogical activity in the field of technical sciences in 143 “Nuclear Power Engineering” and industries in higher education institutions, through the internationalization of the educational process in terms of sustainable innovative scientific and technological development of society and is implemented through:</p> <ul style="list-style-type: none"> <li>- harmonious and multidimensional education of future highly qualified technical specialists, able to comprehensively and systematically analyze the problems of electrical engineering and related industries, realizing the nature of surrounding processes and phenomena, to provide and conduct intercultural communication;</li> <li>- formation of high adaptability of higher education seekers in the conditions of labor market transformation through interaction with employers and other stakeholders.</li> </ul>	

### 3 – Characteristics of the Educational Program

Subject area	<p><b>Objects of study and activity:</b> neutron-physical, radiation, thermohydraulic, hydrochemical processes in nuclear reactors, processes of production, conversion, use of thermal energy, heat and mass transfer in heat exchangers, increase of reliability and prolongation of life time of main and auxiliary equipment of nuclear power plant, NPP decommissioning, radioactive waste and spent nuclear fuel, analysis and ensuring nuclear and radiation safety.</p> <p><b>Objectives of training:</b> training of professionals capable of setting and solving complex tasks in the field of nuclear energy and research and innovation, which involves a deep rethinking of existing and the creation of new holistic knowledge and professional practice.</p> <p><b>Theoretical content of the subject area:</b> principles, concepts, models and theories of processes in the field of nuclear energy.</p> <p><b>Methods, techniques and technologies:</b> calculations and experimental studies of processes in nuclear reactors and in the equipment of the nuclear power industry using modern computer programs.</p> <p><b>Tools and equipment:</b> modern equipment, machinery, control and measuring devices of technological processes in nuclear and power equipment; computer equipment and software packages for measuring and processing experimental data on the study of processes and phenomena in the equipment of complex nuclear and power systems; calculation codes, modern software environments, 3-D modeling and data processing during the study of research objects.</p>
Orientation of the educational program	Educational and scientific
The main focus of the educational program	<p>Special education in the field of knowledge 14 Electrical engineering in the specialty 143 Nuclear Power Engineering.</p> <p>Acquisition of educational qualification for scientific-innovative and scientific-pedagogical professional activity in the field of nuclear energy. The program is based on well-known scientific principles, taking into account the current state of development of the nuclear industry. The program is aimed at forming such competencies of third-level higher education applicants that enable their comprehensive professional, intellectual, social and creative development, taking into account new realities and challenges of today for the implementation of engineering, research and innovation (including international) activities. Applicants of third-level of education have the opportunity to acquire knowledge in related fields, to master modern computer tools for process design and modeling and other educational components through the possibility of forming a flexible individual learning trajectory.</p> <p><b>Keywords:</b> nuclear power plant, research and innovation, nuclear physics, thermohydraulic processes, energy efficiency.</p>
Program specifics	<p>Interdisciplinary scientific-innovative and multidisciplinary training of specialists in the field of nuclear energy. Applicants of third-level of education have scientific and pedagogical practice in specialized enterprises and adopt modern engineering technologies of computer design and research of nuclear power systems. The implementation of the program foresees the involvement of practitioners, industry experts, employers' representatives and other stakeholders in the educational process. Participation of applicants in the Summer Schools for Atomic Energy and in scientific and practical conferences of various levels. Some</p>

	special courses can be taught in English (foreign).
<b>4 – Suitability of Graduates for Employment and Further Study</b>	
Suitability for employment	The specialist is prepared to work in the heat and power industry according to the National Classifier of Ukraine: Classifier of professions ДК 003: 2010. Specialist by qualification level of works: 2121.1 Researcher. 2310.2 Teacher of higher education.
Further educating	Continuation of education in doctoral studies and / or participation in postdoctoral programs
<b>5 – Teaching and Evaluation</b>	
Teaching and learning	Student-centered learning, self-study, problem-oriented learning, learning through laboratory practice. All participants of the educational process are provided with timely and understandable information on the goals, content and program learning outcomes, the procedure and evaluation criteria within individual educational components. The general style of learning is creatively oriented, aimed at the development of skills of generating new ideas and independent acquisition of deep knowledge. The educational process is carried out on the basis of acmeological, axiological, systemic, competence, personality-oriented and innovation-informative approach. A creative learning style is used, which stimulates creativity in cognitive activity and initiative, learning through the practice. Teaching methods: communicative-cognitive, problem statement, heuristic (partly – exploratory), research, discussion. Teaching is carried out in the form of: lectures, seminars, practical classes, laboratory classes in small groups (up to 8 people), independent work with the possibility of consultation with the teacher, individual classes, application of information and communication technologies for individual educational components, mixed technology training, practice and excursions; conducting research; performing a doctoral theses; holding regular conferences, seminars, colloquia, access to the use of laboratories, equipment, etc. It is planned to write scientific articles, which are presented and discussed with the participation of teachers and graduate students.
Evaluation	Current, semester written and oral forms of knowledge control. Current certifications (reporting) are carried out according to the individual plan of scientific work of the graduate student (2 times a year). Approbation of research results at scientific conferences. Publication of research results in professional scientific publications (at least one in a publication that is part of the scientometric database Scopus, Web of Science or other international database defined by the Ministry of Education and Science of Ukraine). Certification is carried out on the basis of public defense of scientific achievements in accordance with the approved procedure.
<b>6 – Program Competencies</b>	
Integral competence	Ability to formulate and solve complex problems in the area of professional and/or research and innovation activities of nuclear energy field, which involves a deep rethinking of existing and the creation of new holistic knowledge and / or professional practice.
<b>General Competencies (GC)</b>	
GC1 Ability to abstract thinking, analysis and synthesis.	
GC2 Ability to search, process, analyze and apply information from various sources, including in a	

foreign language, to carry out research and innovation activities.

**GC3** Ability to generate new ideas and knowledge.

**GC4** Ability to work in an international context.

**GC5** Definiteness and persistence in terms of tasks and responsibilities.

### **Professional Competencies (PC)**

**PC 1** Ability to perform original research, achieve scientific results that create new knowledge in the field of nuclear energy and related interdisciplinary areas and can be published in leading scientific journals in energy engineering and related fields.

**PC 2** Ability to orally and in writing present and discuss the results of scientific research and / or innovative developments in Ukrainian and foreign languages, deep understanding of foreign language scientific texts in the field of research.

**PC 3** Ability to use modern information technologies, databases and other electronic resources, specialized software in scientific and educational activities.

**PC 4** Ability to initiate, develop and implement comprehensive innovative projects in the field of nuclear energy and related interdisciplinary projects.

**PC 5** Ability to formulate a scientific problem (task) that has theoretical and practical significance in the field of nuclear energy, to determine ways to solve it with the involvement of modern theoretical and experimental methods and information technology.

**PC 6** Ability to achieve the ultimate goal of the study - the practical implementation or prospects of such in the perspective of theoretical science.

**PC 7** Ability to carry out scientific and pedagogical activities in higher education in nuclear energy.

**PC 8** Ability to use the latest advances in modern science and advanced technologies in research.

**PC 9** Ability to develop, apply and improve mathematical models, scientific and technical methods and modern computer software for solving complex problems in technical and natural systems.

### **7 – Program Learning Results (PLR)**

**PLR 1** Have advanced conceptual and methodological knowledge of nuclear energy and cross-border industries, as well as research skills sufficient to conduct scientific and applied research at the level of the latest world achievements, gain new knowledge and / or innovate.

**PLR 2** Freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of nuclear energy in state and foreign languages, qualified to reflect the results of research in scientific publications in leading domestic and international scientific journals.

**PLR 3** Formulate and test hypotheses; use appropriate evidence to substantiate the conclusions, in particular, the results of theoretical analysis, experimental research and mathematical and / or computer modeling, available literature data.

**PLR 4** Develop and research conceptual, mathematical and computer models of processes and systems, use them effectively to gain new knowledge and / or create innovative products in the field of nuclear energy and related interdisciplinary areas.

**PLR 5** Plan and perform experimental and / or theoretical research in nuclear energy and related interdisciplinary areas using modern tools, critically analyze the results of their own research and the results of other researchers in the context of the whole set of modern knowledge about the subject problem.

**PLR 6** Apply modern tools and technologies for information retrieval, processing and analysis, in particular, statistical methods of data analysis of large volume and / or complex structure, specialized databases and information systems.

**PLR 7** Based on the results of theoretical and experimental research to develop and implement scientific and / or innovative engineering projects that provide an opportunity to rethink existing and create new holistic knowledge and / or professional practice and solve significant scientific and technological problems in the field of nuclear energy. compliance with the norms of academic ethics.

**PLR 8** Deeply understand modern problems of scientific and technical development of science and technology taking into account world achievements in the fields of energy taking into account



technical and economic and ecological directions, to know and apply modern technologies of energy and resource saving.

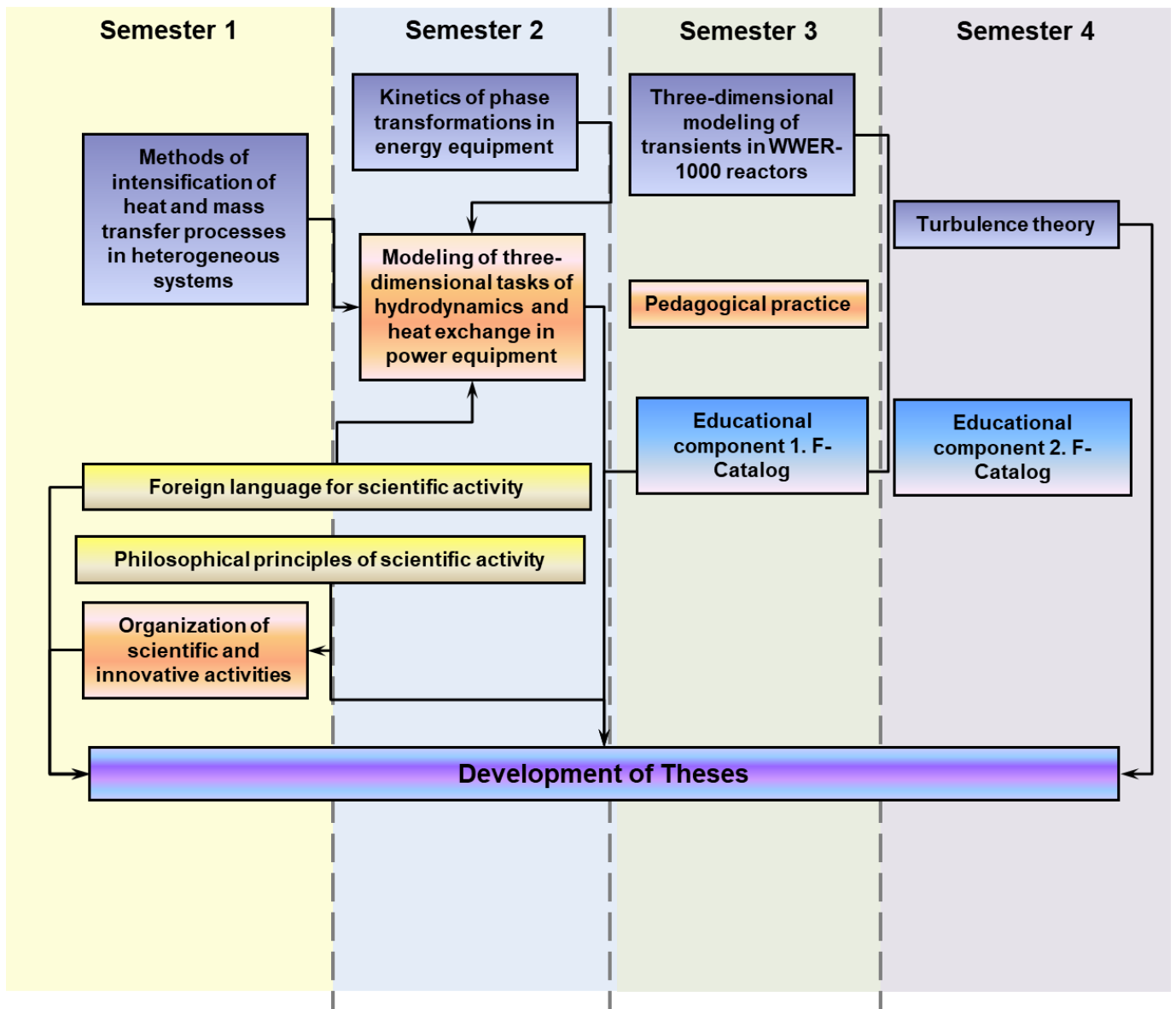
**PLR 9** Create, organize and conduct teaching of professionally-oriented disciplines and develop methodological support at a level that meets the requirements of higher education.

<b>8 – Resource Support for Program Implementation</b>	
Human Resources	In accordance with the personnel requirements for ensuring the implementation of educational activities for the relevant level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 (actual) as amended on 23.05.2018 # 347. The implementation of the program foresees the involvement of practitioners, industry experts, employers' representatives and other stakeholders in the educational process.
Material and Technical Supporting	In accordance with the technological requirements for ensuring the implementation of educational activities for the relevant level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 (actual) as amended on 23.05.2018 # 347. In the course of education a modern software is used: Compass, Ansis, Tekla Structure, Autodesk Inventor.
Information and Educational - Methodical support	In accordance with the technological requirements for teaching and information support of educational activities of the appropriate level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 (actual) as amended on 23.05.2018 # 347. Resources of the G.I. Denisenko Scientific and Technical Library of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" are used in the organization and implementation of the educational process. <a href="https://www.library.kpi.ua/">https://www.library.kpi.ua/</a>
<b>9 – Academic Mobility</b>	
National Credit Mobility	Possibility of concluding agreements on academic mobility and double diploma.
International Credit Mobility	Possibility of concluding agreements on international academic mobility (Erasmus + K1), on double diploma, on long-term international projects, etc., which provide for the included education of students. Agreement on International Academic Mobility (Erasmus + K1) with Middle Eastern Technical University (Ankara, Turkey) Agreement on International Academic Mobility (Erasmus + K1) with the Polytechnic University (Valencia, Kingdom of Spain)
Educating of Foreign Applicants for Higher Education	For foreign citizens, education is provided in Ukrainian. Some special courses might be taught in English (foreign) language.

## 2. LIST OF COMPONENTS OF THE EDUCATIONAL PROGRAM

Code of Educational Component	Components of the Educational Program (academic disciplines, course projects / works), practices, qualification work)	Number of Credits ECTS	Form of Final Control
<b>1. OBLIGATORY (Normative) Components of Educational Program</b>			
<b>1.1. General Training Cycle</b>			
<b>1.1.1. Educational disciplines for mastering general scientific (philosophical) competencies</b>			
ZO 1	Philosophical principles of scientific activity	6,0	Final Test, Exam
<b>1.1.2. Educational disciplines for acquiring language competencies</b>			
ZO 2	Foreign language for scientific activity	6,0	Final Test, Exam
<b>1.1.3. Educational disciplines for obtaining in-depth knowledge of the specialty</b>			
PO 1	Methods of intensification of heat and mass transfer processes in heterogeneous systems	4,0	Exam
PO 2	Kinetics of phase transformations in energy equipment	4,0	Exam
PO 3	Three-dimensional modeling of transients in WWER-1000 reactors	4,0	Exam
PO 4	Turbulence theory	4,0	Exam
<b>1.1.4. Educational disciplines for the acquisition of universal competencies of the researcher</b>			
PO 5	Organization of scientific and innovative activities	3,0	Exam
PO 6	Modeling of three-dimensional tasks of hydrodynamics and heat exchange in power equipment	3,0	Final Test
PO 7	Pedagogical practice	2,0	Final Test
<b>2. ELECTIVE Components of Educational Program</b>			
B 1	Educational component 1. F-Catalog	7,0	Exam
B 2	Educational component 2. F-Catalog	7,0	Exam
Total scope of <b>obligatory required components:</b>		<b>36</b>	
Total scope of <b>vocational components:</b>		<b>14</b>	
<b>TOTAL SCOPE OF EDUCATIONAL PROGRAM</b>		<b>50</b>	

### 3. STRUCTURAL AND LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM



#### 4. SCIENTIFIC COMPONENT

Year of Study	The Content of the Graduate Student's Scientific Work	Form of control
1 year	The choice of the topic of the graduate student's theses, the formation of an individual plan of the graduate student's work; execution of the theses work under the guidance of the scientific supervisor; preparation and submission for publication of at least 1 publication on the topic of the dissertation in accordance with current requirements.	approval by the academic council of the institute / faculty, reporting on the implementation of the individual plan of the graduate student twice a year
2 year	Execution under the guidance of the supervisor of the theses; preparation and submission for publication of at least 1 publication on the topic of the theses in accordance with current requirements.	reporting on the progress of the individual graduate student's plan twice a year
3 year	Execution under the guidance of the supervisor of the theses; preparation and submission for publication of at least 1 publication on the topic of the theses in accordance with current requirements.	reporting on the progress of the individual graduate student's plan twice a year
4 year	Completion of the theses, summarizing the results of publications (at least three) on the topic of theses in accordance with current requirements. Submission of documents for preliminary examination of the theses. Graduation certification	reporting on the progress of the individual graduate student's plan twice a year. Providing a conclusion on the scientific actuality, theoretical and practical significance of the dissertation results. PhD thesis defense.

## **5. HIGHER EDUCATION CERTIFICATION FORM**

Certification of higher education students in the educational and scientific program Atomic Energy, specialty 143 Nuclear Power Engineering is carried out in the form of defense of the theses and ends with the issuance of a standard document on awarding the degree of Doctor of Philosophy with the qualification: Doctor of Philosophy in Nuclear Power Engineering.

Qualification work is checked for plagiarism and after the defense is placed in the repository of Scientific and Technical Library of University for free access. Certification is carried out openly and publicly.

## 6. MATRIX OF CONFORMITY

### 6.1 Matrix of correspondence of program competencies to the components of the educational component of the program

	ZO 1	ZO 2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	Scientific Component
GC1	+					+				+
GC2		+	+							+
GC3	+		+				+			+
GC4		+				+				+
GC5							+		+	+
PC1										+
PC2		+					+			+
PC3					+		+	+		+
PC4			+							+
PC5			+	+	+	+				+
PC6				+			+			+
PC7		+							+	
PC8				+				+		+
PC9					+			+		+

### 6.2 Matrix for providing software learning outcomes with the relevant components of the educational component of the program

	ZO 1	ZO 2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	Scientific Component
PLR1	+		+	+	+					+
PLR2		+								+
PLR3			+	+	+	+	+			+
PLR4					+	+		+		+
PLR5				+			+			+
PLR6					+			+		+
PLR7				+		+	+			+
PLR8	+		+				+			+
PLR9									+	