MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
LVIV POLYTECHNIC NATIONAL UNIVERSITY

«APPROVED»
Rector
Lviv Polytechnic National University

_____ /Bobalo Y. Y./
«_____» _____ 2022

Educational and scientific program

the third level of higher education

Specialty 122 *Computer Science*

branch of knowledge 12 *Information Technologies*

Qualification: the Doctor of Philosophy, specialty *Computer Science*

Considered and approved
at the meeting of the Academic Council
(minutes ___
from «__» _____ 2022)

Lviv 2022

Developed by a working group (specialty 122 Computer Sciences) consisting of:

Head of the working group (guarantor):	- Doctor of Technical Sciences, Professor, Director of the Institute of Computer Science and Information Technologies Medykovskyi Mykola Oleksandrovych
Members:	- Doctor of Technical Sciences, Professor, Head of the Department of Artificial Intelligence System Shakhovska Nataliia Bohdanivna
	- Doctor of Technical Sciences, Professor, Head of the Department of Computer-Aided Design Lobur Mykhailo Vasyliovych
	- Doctor of Technical Sciences, Professor, Head of the Department of Automated Control Systems Tesliuk Vasyl Mykholayovych
	- Candidate of Technical Sciences (Ph.D), Associate Professor, Dean of the second (Master) level of higher education, Institute of Computer Sciences and Information Technologies Marikutsa Uliana Bohdanivna
	- Candidate of Technical Sciences (Ph.D), Associate Professor, Head of the Resource Development laboratory EPAM SYSTEMS Hryniov Denys
	- Postgraduate student at the Department of Artificial Intelligence System
	- student of the group CSM-21

Guarantor Doctor of Technical Sceinces, Professor Medykovskyi M. O.
(academic degree, academic title, full name, signature)

Implemented by order of the Rector of Lviv Politechnic National University
«__» _____ 2022. № _____.

APPROVAL PAGE
educational and scientific program

Higher education level	the third (educational and scientific)
Branch of knowledge	*12 Information Technologies*
Specialty	*122 Computer Science*
Qualification	the Doctor of Philosophy in Computer Science

APPROVED
Scientific-Methodical Commission on the specialty *122 Computer Science*
Minutes №_____
«__» _____ 2022

Head of SMC on the specialty
122 Computer Science
_____U.B. Marikutsa
«__» _____ 2022

Director of the Institute of Computer Science and Information Technologies

_____ M.O. Medykovskyi
«__» _____ 2022

RECOMMENDED
Head of the Educational ans Methodical Department
_____ Sviridov V.M.
«__» _____ 2022

Vice-rector for scientific work

_____ Demydov I.V.
«__» _____ 2022

Vice-rector for scientific and pedagogical work

_____ Davydchak O.R.
«__» _____ 2022

RECOMMENDED
University Scientific and Methodical Council
Minutes №_____
«__» _____ 2022
Head of the SMC Council
_____ A.H. Zahorodnii

EDUCATIONAL COMPONENT OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM

1. The profile of Doctor of Philosophy Program in the field of 12 «Information Technologies» on specialty 122 «Computer Science»

1 – General Information	
1	2
The full name of the institution of higher education and the name of the structural unit	Lviv Polytechnic National University
Full name of qualification (in original language)	Доктор філософії з Комп'ютерних наук Doctor of Philosophy in computer sciences
The official name of educational and scientific program	Computer science
Program type and educationam program scope	Doctor of Philosophy, single, the educational component consists of 43 ECTS credits, duration – 2 years
Cycle/level of program	Ukraine national qualifications frameworks – 8 level, FQ-EHEA – 3rd cycle, EQF-LLL – 8 level
Prerequisies	Master's degree
Language of instruction	Ukrainian
Key concepts and their definitions	The educational and scientific programme uses the key concepts and their definitions in accordance with the Law of Ukraine "On Higher Education" from 01.07.2014 No. 1556-VII (amended), the Law of Ukraine "On Scientific and Technical Activities" from 26.11.2015 No. 848-VIII (amended), the Regulations for postgraduate students to obtain a degree of Doctor of Philosophy and Doctor of Sciences in higher education institutions (research institutions), approved by the Resolution of the Cabinet of Ministers from 23.03.2016 No. 261 (amended in 2019). order No. 394 from 28.04.2022 on the standard of higher education in the speciality 122 Computer Science for the third (educational and scientific) level of higher education.
2 – The purpose of the educational and scientific program	
	Acquire the ability to produce new ideas, solve complex scientific and applied problems and/or problems in the field of professional and/or research-innovative activity in the field of computer science, which involves a deep rethinking of existing and creating new holistic knowledge of professional practice.
3 – Characteristics of the educational and scientific program	
Subject ares (knowledge area, specialty)	Knowledge area - 12 «Information Technologies» Specialty - 122 «Computer Science»

Aim of the educational and scientific program	The educational and scientific program is aimed at relevant aspects of the specialty and allows a further scientific and teaching career.

Continued

1	2
Program features	The educational and scientific program covers a wide range of modern development innovative vectors of the theory and practice of computer science and information technologies, which forms an updated theoretical and applied fundamentals for conducting scientific research
4 – Eligibility of graduates for employment and further education	
Eligibility for employment	Scientific and scientific-pedagogical positions in institutions and institutions of higher education, engineering, expert, analytical, etc. positions in IT, divisions of scientific and research enterprises, design and construction enterprises, institutions and organizations.
Further education	The right to obtain a Doctor of Sciences degree and additional qualifications in the education system for adults.
5 – Teaching and assessment	
Teaching and learning	Lectures and practical classes, pedagogical practical training, consulting with a scientific supervisor, a scientific and pedagogical staff and independent scientific and educational work.
Assessment	Examinations, credit tests, current control, oral presentation
6 – Program competencies	
Integral competence (IC)	The ability to produce innovative ideas, solve complex problems in the field of computer science, apply the methodology of scientific and pedagogical activities, as well as conduct their own research, the results of which have scientific novelty, theoretical and practical values.
General competence (GC)	GC01. Ability to solve computer science complex problems based on scientific outlook and general cultural outlook in compliance with the principles of professional ethics and academic integrity. GC02. Ability to work in international environment. GC03. Ability to organise and conduct classes, impliment modern information technologies (work with Virtual Learning Environment, Microsoft Teams, Zoom, etc.). GC04. Ability to search, process and analyse information from various sources. GC05. Ability to acquire systematic knowledge of modern research methods in the field of computer science and information technology, as well as in related fields. GC06. Ability to develop abstract thinking, analysis and synthesis. GC.07. Mastering the ability to initiate and conduct original scientific research, identify current scientific problems, search for and critically analyse information, produce innovative constructive ideas and apply non-standard approaches to solving complex and atypical problems.

Continued

1	2
Professional competence of spwcialty (PC)	PC01. Ability to analyse and evaluate the current state and trends in the development of computer science and information technologirs. PC02. Ability to apply modern methodologies, methods and tools of experimental and theoretical research in the field of computer science, modern digital technologies, databases and other electronic resources in scientific and educational activities. PC03. Ability to identify, formulate and solve research and applied tasks and/or problems in the field of computer science, evaluate and ensure the research quality. PC04. Ability to initiate, develop and implement complex innovative projects in the field of computer science and related interdisciplinary projects, demonstrate leadership in their implementation. PC05. Ability to carry out research and give classes in the field of computer science in higher education institutions. PC06. Ability to perform quaint research, achieve scientific results that create new knowledge in computer science and related interdisciplinary areas and findings can be published in leading scientific journals in computer science and related fields.
7 – Program learning outcomes	
Knowledge Outcomes (KO)	LO01. Possess advanced conceptual and methodological knowledge in computer science and on interdisciplinary subject areas, as well as research skills sufficient to conduct scientific and applied research at the level of the latest world achievements in the relevant field, obtain new knowledge and/or implement innovations. LO02. Ability to demonstrate the impact of technical solutions in a societal, economic and social context. LO03. To develop and implement scientific and/or innovative engineering projects that make it possible to rethink existing and create new holistic knowledge and/or professional practice and solve significant and technological problems of computer science in compliance with the norms of academic ethics and taking into account social, economic, environmental and legal aspects. LO04. Ability to demonstrate knowledge and understanding of the philosophical methodology of scientific cognition, psychological and pedagogical aspects of professional and scientific activity, own scientific worldview and moral and cultural values. LO05. Apply modern tools and technologies for searching, processing and analysing information, in particular, statistical methods for analysing large and/or complex data, specialised databases and information systems.

Continued

1	2
Skills Outcomes (SO)	LO06. Identify current scientific and practical problems in the field of computer science, deeply understand the general principles and methods of computer science, as well as the methodology of scientific research, apply them in their own research in the field of computer science and in teaching practice. LO07. To study, summarise and implement computer science innovations in the educational process. LO08. Develop and research conceptual, mathematical and computer models of processes and systems, effectively use them to obtain new knowledge and/or create innovative products in computer science and related interdisciplinary areas. LO09. Organise and carry out the educational training in the field of computer science, use scientific, educational, methodological and regulatory materials and aids, apply effective methods in teaching. LO10. Plan and carry out experimental and/or theoretical research in computer science and related interdisciplinary areas using modern tools, critically analyse the results of own research and the results of other researchers in the scope of modern knowledge being studied. S11. Find, assess and critically analyse information on the current state and trends of development, research tools and methods, scientific and innovative projects in computer science.
Communication (Com)	1. Present and discuss the research findings, scientific and applied problems of computer science in Ukrainian and foreign languages with specialists and non-specialists 2. Publisg findings in scientific publications in leading international scientific journals.
Autonomy and responsibility (AR)	1. Ability to conduct scientific research and make decisions independently. 2. Ability to draw own conclusions, offer suggestions and make recommendations. 3. Ability to be aware of and take personal responsibility for the research findinds.

Continued

1	2
8 – Resource support for the implementation of the program	
Specific characteristics of staffing	100% of academic staff involved in teaching disciplinces that ensure postgraduate student's special (professional) competences have academic degrees and academic titles.
Special characteristics of logistics and technical support	Use of open source software in computer laboratories.
Specific characteristics of information, teaching and methodological support	Use Virtual Learning Environment of Lviv Polytechnic National University and materials developed by scientific and pedagogical staff.
9 – Academic Mobility	
National Credit Mobility	Based on bilateral agreements between Lviv Polytechnic National University and Ukrainian universities.
International Credit Mobility	Within the framework of the EU Erasmus+ programme based on bilateral agreements between Lviv Polytechnic National University and partner countries educational institutions.
Training of foreign portgraduate students	Possible

2. The components of educational and scientific programme and their distribution

№	Components	Postgraduate's academic workload (credits / %)		
		Mandatory components	Optional components	Total numbet for the whole period
1.	Cycle of disciplines that form general scientific competences and the most essential skills of a researcher	21/49	3/7	24/56
2.	Cycle of disciplines that form professional competences	10/23	6/14	16/37
3.	Cycle of disciplines which postgraduate students can choose	-	3/7	3/7
Total number for the whole period		31/72	12/28	43/100

3. List of academic disciplines

Code	Components	Number of ECTS credits	Final assessment form
1	2	3	4
***1.* Mandatory aducational disciplines**			
Components that form general scientific competences and the most essential skills of a researcher			
MC1.1.	Philosophy and methodology of science	3	exam
MC1.2.	Foreign language for academic purposes, part 1	4	credit test
MC1.3.	Foreign language for academic purposes, part 2	4	Exam
MC1.4.	Professional pedagogy	3	credit test
MC1.5.	Academic entrepreneurship	4	credit test
MC1.6.	Pedagogical practice	3	credit test
Total number:		**21**	
Components that form professional competences			
MC2.1.	Methods for analysing and optimising complex systems **AIS**	4	Exam
MC2.2.	Information technologies for managing smart systems **ACS**	3	Exam
MC2.3.	Modern methods of intelligent systems design **CAD**	3	Exam
Total number:		**10**	

continued

1	2	3	4
2. Optional components of free choice *			
Academic disciplines that form general scientific competences and the most essential skills of a researcher			
OC1.1	Business foreign language	3	credit test
OC1.2	Psychology of creativity and invention	3	credit test
OC1.3	Research project management	3	credit test
OC1.4	Technology for processing grant applications and patent rights	3	credit test
OC1.5	Rhetoric	3	credit test
OC1.6	Modern inventory in research and development	3	credit test
OC1.7	Open science practices	3	credit test
OC1.8	Academic integrity and education quality	3	credit test
OC1.9	Methodology for writing scientific publications	3	credit test
OC1.10	Quality of higher education (formation of internal quality assurance systems)	3	credit test
Total number:		**3**	
2.1.Components that form professional competences			
OC2.1	Information technologies for managing socio-economic and technical systems **ACS**	3	exam
OC2.2	Data protection information technology **CAD**	3	exam
OC2.3	Modern approaches to designing smart buildings and systems **CAD**	3	exam
OC2.4	Design of intelligent systems and devices **CAD**	3	exam
OC2.5	Machine learning technologies **AIS**	3	exam
OC2.6	Modern signal and image processing technologies **ACS**	3	exam
OC2.7	системах Methods of computational intelligence in smart systems **ACS**	3	exam
OC2.8	Prediction methods on big data **AIS**	3	exam
OC2.9	Online machine learning techniques **AIS**	3	exam
OC2.10	Fast machine learning tools for data analysis and forecasting **PST**	3	exam
Total number:		**6**	
Optional disciplines*			
OC3.1	Optional disciplines	3	Credit test
Total number:		**3**	
TOTAL		43	

4. Matrix of compatibility of programme competences to the components of educational program

	MC 1.1.	MC 1.2.	MC 1.3.	MC 1.4.	MC 1.5.	MC 1.6.	MC 2.1.	MC 2.2.	MC 2.3.	OC 1.1.	OC 1.2.	OC 1.3.	OC 1.4.	OC 1.5.		OC 1.6.	OC 1.7.	OC 1.8.	OC 1.9.	OC 1.10.		OC 2.1.	OC 2.2.	OC 2.3.	OC 2.4.	OC 2.5.	OC 2.6.	OC 2.7.	OC 2.8.	OC 2.9.	OC 2.10.	OC 3.1.
INC								•			•		•				•		•			•			•							
GC1	•									•	•	•	•	•		•	•	•	•	•												
GC2		•	•							•	•	•	•	•		•	•	•	•	•												
GC3				•		•				•	•	•	•	•		•	•	•	•	•												
GC4					•					•	•	•	•	•		•	•	•	•	•												
GC5																						•		•	•	•			•		•	
GC6																							•			•		•	•			•
GC7																						•		•		•	•			•		•
PC1							•	•														•	•			•			•	•	•	
PC2									•														•	•	•		•	•		•	•	
PC3								•															•	•	•		•			•		•
PC4							•															•			•	•	•		•	•		•
PC5									•													•	•	•		•	•	•	•		•	
PC6								•																•		•			•		•	

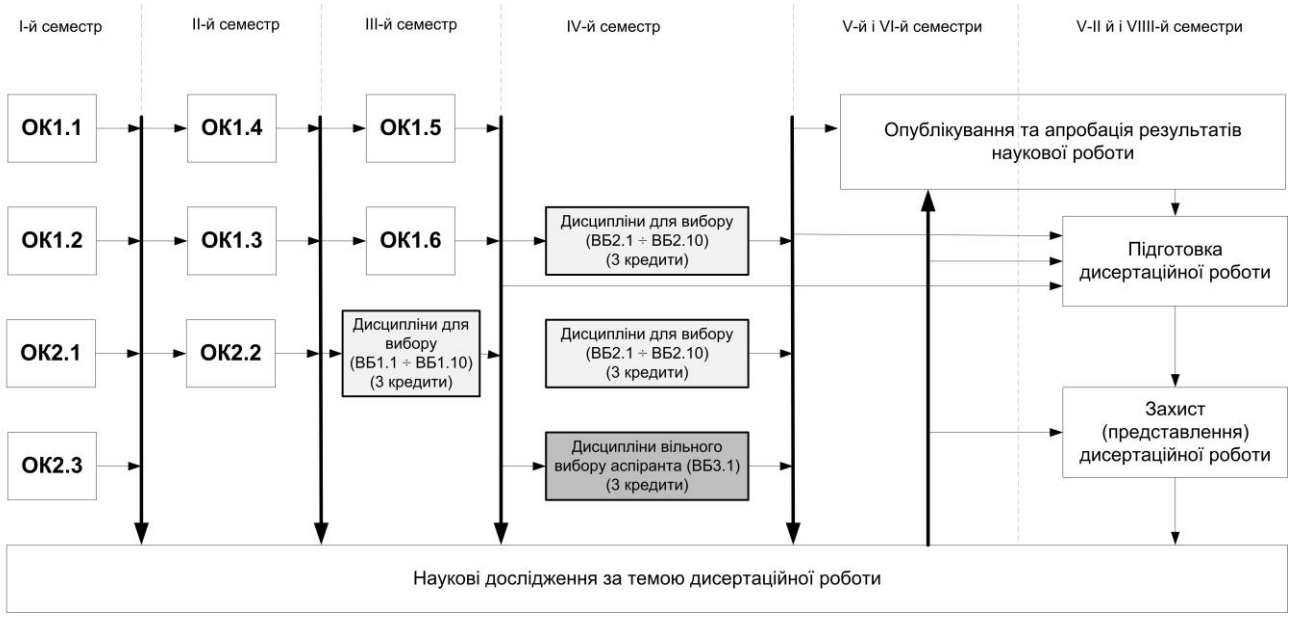
Abbreviations: MCi - compulsory component, OCi - optional component, i - discipline number in the list of components of the educational component, INC - integral competence, GCj - general competence, PCj - professional (special) competence, j - competence number in the list of competences of the educational component.

5.
Matrix for ensuring programme learning outcomes with the relevant components of the educational program

	MC1.1.	MC 1.2.	MC 1.3.	MC 1.4.	MC 1.5.	MC 1.6.	MC 2.1.	MC 2.2.	MC 2.3.	OC 1.1	OC 1.2.	OC 1.3.	OC 1.4.	OC 1.5.	OC 1.6.	OC 1.7.	OC 1.8.	OC 1.9.	OC 1.10.	OC 2.1.	OC 2.2.	OC 2.3.	OC 2.4.	OC 2.5.	OC 2.6.	OC 2.7.	OC 2.8.	OC 2.9.	OC 2.10.	OC 3.1.
KO1								•	•	•																				
KO2	•				•			•	•	•	•			•			•	•	•	•	•	•	•				•	•	•	•
KU3	•				•			•		•	•			•			•	•	•	•	•	•	•				•	•	•	•
KO4	•				•	•	•	•	•	•	•			•					•	•			•	•			•	•		•
KO5	•			•	•	•	•						•	•	•						•	•							•	•
SO1	•				•	•	•	•		•	•			•						•								•		•
SO2	•				•	•	•	•		•	•			•			•	•	•	•	•	•	•				•	•	•	•
SO3	•				•	•	•	•	•	•	•			•					•	•			•	•			•	•		•
SO4	•			•	•	•	•						•	•	•															•
SO5	•				•			•		•	•			•					•	•			•	•	•		•	•		•
SO6		•	•			•	•					•				•										•				
COM1		•	•			•	•					•				•										•				
COM2		•	•			•	•					•				•										•				
A&R1				•			•						•		•							•			•					
A&R2				•			•						•									•			•					
A&R3				•			•						•									•								

Abbreviations: MCi – mandatory component, OCi - optional component, i - discipline number in the list of components of the educational program, KOm - programme outcomes (knowledge), SOm - program outcomes (skills), m - programme outcome number in the list of programme outcomes of the educational program.

6. Structural and logical diagram of the educational and scientific programme of the third (educational and scientific) level of higher education in the speciality 122 "Computer Science"



Наукові дослідження за темою дисертаційної роботи - Scientific research on the dissertation topic
ОК - MC
I-й семестр – Ist semester
Дисципліни для вибору (ВБ 1.1+ВБ 1.10 (3 кредити) – Optational disciplines (OC 1.1+OC 1.10) (3 ECTS credits)
Дисципліни для вибору (ВБ 2.1+ВБ 2.10 (3 кредити) – Optational disciplines (OC 2.1+OC 2.10) (3 ECTS credits)
Дисципліни для вибору (ВБ 2.1+ВБ 2.10 (3 кредити) – Optational disciplines (OC 2.1+OC 2.10) (3 ECTS credits)
Дисципліни вільного вибору аспірантів (ВБ 3.1) (3 кредити) – Disciplines of free choice for postgraduate students (OC 3.1) (3 ECTS credits)
Опублікування та апробація результатів наукової роботи – Publication and testing of research results
Підготовка дисертаційної роботи – Writing a dessertation
Захист (представлення) дисертаційної роботи – Defence (presentation) of the dessertation

II. Scientific component of the program

The scientific component of the programme involves a postgraduate student conducting their own research under the guidance of one or two supervisors and presenting its results in the form of a dissertation.

A dissertation for the degree of Doctor of Philosophy is an independent detailed study that offers a solution to an actual scientific problem in the specialty **122 "Computer Science"**, the results of which make an original contribution to the amount of knowledge in the specialty **122 "Computer Science"** and are published in relevant publications.

The scientific component of the programme is drawn up in the form of an individual plan of scientific work of a postgraduate student and is an integral part of the curriculum of the postgraduate study.

An integral part of the program scientific component is the writing and publication of scientific articles, speeches at scientific conferences, scientific professional seminars, round tables, symposia.

Scientific research topics for the speciality 122 "Computer Science":

1. Creation and application of information technologies and information systems for automated information processing and management.

2. Information technologies for the analysis and synthesis of structural, informational and functional models of automated objects and processes.

3. Models and methods for automating the performance of functions and tasks for production and organisational management in conventional and multi-level structures based on the creation and use of new information technologies.

4. Information technologies for the development and implementation of databases and data warehouses, knowledge bases and computer decision support systems in automated systems and networks.

5. Information technologies for the implementation of communication protocols and tools for the construction of universal and specialised computer systems and networks, including systems of computerisation of education.

6. Information technologies for system analysis, research, development of architecture and methods for building multi-level, geographically dispersed computer systems and networks with distributed databases and knowledge, including commercial applications.

7. Information technologies for effective software development of computer networks and distributed data processing systems.

8. Information technologies for developing control models and methods, classification, coding and maintenance of information reliability, as well as for mathematical modelling of errors in data exchange paths in information telecommunication networks.

9. Subject areas modelling of information systems (analytical, simulation, infological, object-oriented, etc.) based on development and implimentation of appropriate information technologies.

10. Development of information retrieval and expert information processing systems for decision-making, as well as knowledge-based decision support systems under conditions of risk and uncertainty as intelligent information technologies.

11. Information technologies for the construction and implementation of: automated technical diagnostic systems, geographic information systems for various purposes and computer systems for e-business.

12. Information technologies for the development of models, methods and tools for automation of information retrieval and telecommunication systems, networks and information support tools for libraries, museums and archives (electronic catalogues, automated workstations, computer bibliography, automated document import systems, etc.)

13. Development and research of models and methods for quality assessment and improvement of reliability, functional safety and survivability of information and information management systems, as well as information technologies to create reliable automated information processing and management systems for critical applications.

14. . Research, development and implementation of Internet technologies for building service-oriented systems, as well as for organising and implementing distributed information processing systems.

15. Applied software systems.

16. Instrumental software systems and methodology of special software development.

17. Intellectualisation of computer and software systems, knowledge engineering.

18. Methods and means of formal tasks specification, models and problem areas.

19. Methods and tools for formal verification, synthesis of models and software of computer systems and networks.

20. Creating and using artificial and natural languages to control computing.

IV. Requirements for an internal quality assurance system for higher education

Lviv Polytechnic National University has a system to ensure the quality of educational activities and the quality of higher education (internal quality assurance system), which includes the following procedures and components:

- defining the principles and procedures for the higher education quality ensurance;
- educational programmes monitoring and updating;
- annual evaluation of higher education students, scientific and teaching staff, publication of the results of such evaluations on the official website of the higher education institution, on information boards and in any other way;
- providing advanced training for pedagogical, scientific and scientific-pedagogical staff;
- ensuring the availability of the necessary resources for the organisation of the educational process, including independent work of students regarding each educational programme;
- ensuring the availability of information systems for effective management of the educational process;
- ensuring that information on educational programmes, degrees of higher education and qualifications is made public;
- ensuring an effective system for preventing and detecting academic plagiarism in the scientific works of employees and students;
- other procedures and measures.

The system of ensuring the educational process quality and the higher education quality (internal quality assurance system) on the request of a higher education institution is evaluated by the National Quality Assurance Agency for Higher Education or its accredited independent institutions for evaluation and higher education quality assurance for its compliance with the requirements for the higher education quality assurance system approved by the National Quality Assurance Agency for Higher Education and international standards and recommendations for quality assurance.

III. Postgraduate students’ certification

The certification of postgraduate students is carried out by Specialised Academic Council, operating permanently or formed for a one-time defence only, based on a public defence of scientific achievements in the form of a dissertation.

A prerequisite for admission to the defence is the successful completion of the postgraduate student’ s individual study plan.

In the main post graduate students defend their thesis in a permanent Specialised Ccademic Council of the relevant speciality, which functions in the higher education institution where the postgraduate student has been trained. The Academic Council has the right to appply to the National Quality Assurance Agency for Higher Education to establish a Specialised Academic Council for one-time defence, or to apply to another higher education institution which has a permanent Specialised Academic Council in the relevant field.