MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
LVIV POLYTECHNIC NATIONAL UNIVERSITY

«APPROVED»
Rector
Lviv Polytechnic National University
_____/Bobalo Y. Y./
«_29_» ____12____2023

Educational and scientific program

Computer Sciences

the third level of higher education

Specialty 122 *Computer Sciences*

branch of knowledge 12 *Information Technologies*

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

Considered and approved
at the meeting of the Academic Council
(minutes № 7
from « 28 » 12 2023)

Lviv 2023

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 № 3-2023/2024
«23» 10 2023

Head of SMC on the specialty *122 Computer Science*
_____U.B. Marikutsa
«23» 10 2023

Director of the Institute of Computer Science and Information Technologies
_____M.O. Medykovskyi
«23» 10 2023

RECOMMENDED
Head of the Educational ans Methodical Department
_____Tomyuk V.V.
«23» 12 2023

Vice-rector for scientific work
_____Demydov I.V.
«21» 12 2023

Vice-rector for scientific and pedagogical work
_____Davydchak O.R.
«22» 12 2023

RECOMMENDED
University Scientific and Methodical Council
Minutes № 75
«21» 12 2023
Head of the SMC Council
_____A.H. Zahorodnii

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
«29» 12 2023. № 676-1-10

EDUCATIONAL COMPONENT OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM

1. Profile of the Doctor of Philosophy program in the field 12 "Information Technologies" in the specialty 122 "Computer Sciences"

1	2
1 – General information	
Full name of the higher education institution and structural unit	**Lviv Polytechnic National University**
Full name	**Doctor of Philosophy in Computer Sciences**
Official name of the educational and scientific program	Computer sciences
Type of diploma and scope of educational program	Doctor of Philosophy degree, single, 43 ECTS credits of the educational component of the educational and scientific program, duration of the educational component of the educational and scientific program – 2 years
Cycle/level	NQF of Ukraine – level 8, FQ-EHEA – third cycle, EQF-LLL – level 8
Prerequisites	Level of higher education "Master"
Languages	Ukrainian, English
Basic concepts and their definitions	The educational and scientific program uses the basic concepts and their definitions in accordance with the Law of Ukraine "On Higher Education" dated 01.07.2014 No. 1556-VII, as amended, the Law of Ukraine "On Scientific and Scientific and Technical Activity" dated 26.11.2015 No. 848-VIII, as amended, the Procedure for Training Applicants for the Degree of Doctor of Philosophy and Doctor of Sciences in Higher Educational Institutions (Scientific Institutions), approved by the Resolution of the Cabinet of Ministers dated 23.03.2016 No. 261 (as amended in 2019). Order No. 394 dated 28.04.2022 on Approval of the Higher Education Standard in Speciality 122 Computer Science for the Third (Educational and Scientific) Level of Higher Education.
2 – The purpose of the educational and scientific program	
	Acquiring the ability to produce new ideas, solve complex scientific and applied tasks and/or problems in the field of professional and/or research and innovation activities in the field of computer science,

1	2
	which involves a profound rethinking of existing knowledge and the creation of new holistic knowledge of professional practice.
3 - Characteristics of the educational and scientific program	
Subject area (field of knowledge, specialty)	Field of knowledge - 12 "Information Technologies" Specialty - 122 "Computer Sciences"
Orientation of the educational and scientific program	The educational and scientific program is aimed at relevant aspects of the speciality, within which a further scientific and teaching career is possible.
Program features	The educational and scientific program covers a wide range of modern, innovative vectors for the development of the theory and practice of computer science and information technologies, thereby forming an updated theoretical and applied basis for conducting scientific research.
4 – Eligibility of graduates of the educational and scientific program for employment and further education	
Employment eligibility	Positions of scientific and scientific-pedagogical employees in institutions and higher education institutions, engineering, expert, analytical, etc., positions in IT, research and design departments of enterprises, institutions and organisations.
Further training	The right to obtain a PhD degree and additional qualifications in the adult education system.
5 – Teaching and assessment	
Teaching and learning	A combination of lectures and practical classes, pedagogical practicum, consulting with a scientific supervisor, scientific and pedagogical community with independent scientific and educational work.
Assessment	Exams, tests, ongoing control, and oral presentations.
6 – Competencies	
Integral competence (INT)	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 one's own scientific research, the results of which have scientific novelty, theoretical and practical significance.
General competencies (GK)	GK01. Ability to solve complex problems of computer science based on a systematic scientific worldview and a general cultural outlook, adhering to the principles of professional ethics and academic integrity. GK02. Ability to work in an international context.

1	2
	GK03. Ability to organise and conduct training sessions, use modern information technologies (work with VNS, Microsoft Teams, Zoom, etc.). GK04. Ability to search, process and analyse information from various sources. GK05. Ability to acquire systemic knowledge of modern methods of conducting research in the field of computer science and information technology, as well as in related fields. GK06. Ability to think abstract, analysis and synthesise. GK.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 tasks.
Special (professional) competencies (PK)	PK01. Ability to analyse and evaluate the current state and trends in the development of computer science and information technology. PK02. 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. PK03. Ability to identify, set and solve research, scientific and applied tasks and/or problems in the field of computer science, evaluate and ensure the quality of research performed. PK04. Ability to initiate, develop and implement complex innovative projects in the field of computer science and related interdisciplinary projects, demonstrating leadership during their implementation. PK05. Ability to carry out scientific and pedagogical activities in higher education in the field of computer science PK06. The ability to perform original research, achieve scientific results that create new knowledge in computer science and related interdisciplinary areas and publish them in leading scientific journals in computer science and related fields.
7 – Program learning outcomes	
Knowledge (KN)	KN1 (PLO1). Have advanced conceptual and methodological knowledge in computer science and at the border of 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.

1	2
	KN2 (PLO2). Ability to demonstrate understanding of the impact of technical solutions in a social, economic and societal context. KN3 (PLO3). 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 computer science while adhering to the norms of academic ethics and taking into account social, economic, environmental and legal aspects. KN4 (PLO4). Ability to demonstrate knowledge and understanding of the philosophical methodology of scientific knowledge, psychological and pedagogical aspects of professional and scientific activity, one's own scientific worldview and moral and cultural values. KN5 (PLO5). Apply modern tools and technologies for searching, processing, and analysing information, in particular statistical methods for analysing large-scale and/or complex data, as well as specialised databases and information systems.
Skills (SK)	SK1 (PLO6). 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, and apply them in one's own research in the field of computer science and in teaching practice. SK2 (PLO7). Study, generalise and implement computer science innovations in the educational process. SK3 (PLO8). Develop and research conceptual, mathematical, and computer models of processes and systems, and effectively use them to generate new knowledge and/or create innovative products in computer science and related interdisciplinary areas. SK4 (PLO9). Organise and implement the educational process in the field of computer science, its scientific, educational, methodological and regulatory support, and apply effective methods of teaching academic disciplines. SK5 (PLO10). Plan and carry out experimental and/or theoretical research in computer science and related interdisciplinary areas using modern tools, and critically analyse the results of their own research and those of other researchers in the context of the entire complex of contemporary knowledge on the problem under study.

1	2
	SK6 (PLO11). Search, evaluate and critically analyse information on the current state and development trends, research tools and methods, and scientific and innovative projects in computer science.
Communication (COM)	COM1 (PLO12). To freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of computer sciences in the state and foreign languages. COM2 (PLO13). To publish the results of research in scientific publications in leading international scientific journals.
Autonomy and responsibility (AR)	AR1 (PLO14) Ability to conduct independently scientific research and make decisions. AR2 (PLO15) Ability to formulate one's own author's conclusions, proposals and recommendations. AR3 (PLO16) Ability to realise and bear personal responsibility for the obtained research results.
8 – Resource provision for the implementation of the educational program	
Specific characteristics of human resources	100% of scientific and pedagogical workers involved in teaching the cycle of disciplines that provide special (professional) competencies of the postgraduate student have scientific degrees and academic titles
Specific characteristics of logistics support	Use of freely available software for the technical support of computer laboratories
Specific characteristics of information and methodological support	Using the virtual learning environment of the Lviv Polytechnic National University and the original developments of scientific and pedagogical workers
9 – Academic mobility	
National credit mobility	Based on bilateral agreements between the National University "Lviv Polytechnic" and the universities of Ukraine
International credit mobility	Within the framework of the EU Erasmus+ program, based on bilateral agreements between the National University of Lviv Polytechnic and educational institutions of partner countries
Education of foreign postgraduate students	Possible

1. Distribution of the content of the educational component of the educational and scientific program by groups of components and training cycles

№	Training cycles	Postgraduate student workload (credits / %)		
		Required components of the educational component	Elective components of the educational component	Total for the entire period of study
1.	A cycle of disciplines that form general scientific competencies and universal skills of a researcher	21/49	3/7	24/56
2.	Cycle of disciplines that form professional competencies	10/23	6/14	16/37
3.	Cycle of disciplines of free choice of a postgraduate student	-	3/7	3/7
Total for the entire period of study		31/72	12/28	43/100

3. List of components of the educational component of the educational and scientific program

#	Components of the educational component	ECTS	Assessment form
1	2	3	4
1. Mandatory components of the educational component			
A cycle of disciplines that form general scientific competencies and universal skills of a researcher			
MC1.1.	Philosophy and Methodology of Science	3	exam
MC1.2.	Foreign Language for Academic Purposes, Part 1	4	test
MC1.3.	Foreign Language for Academic Purposes, Part 2	4	exam
MC1.4.	Professional Pedagogy	3	test
MC1.5.	Academic Entrepreneurship	4	test
MC1.6.	Teaching Practice	3	test
Total per cycle:		**21**	
A cycle of disciplines that form professional competencies			

1	2	3	4
MC2.1.	Methods for Analysis and Optimisation of Complex Systems	4	exam
MC2.2.	Information Technologies for Managing Smart Systems	3	exam
MC2.3.	Modern Methods of Designing Intelligent Systems	3	exam
Total per cycle:		**10**	
2. Elective components of the educational component *			
A cycle of disciplines that form general scientific competencies and universal skills of a researcher			
EC1.1	Business Foreign Language	3	test
EC1.2	Psychology of Creativity and Invention	3	test
EC1.3	Scientific Project Management	3	test
EC1.4	Technology of Grant Applications and Patent Rights	3	test
EC1.5	Rhetoric	3	test
EC1.6	Modern Invention in Research Activities	3	test
EC1.7	Open Scientific Practices	3	test
EC1.8	Academic Integrity and Quality of Education	3	test
EC1.9	Methodology of Preparation of Scientific Publications	3	test
EC1.10	Quality of Higher Education (Formation of Internal Quality Assurance Systems)	3	test
Total per cycle:		**3**	
A cycle of disciplines that form professional competencies			
EC2.1	Information Technologies for Managing Socio-Economic and Technical Systems	3	exam
EC2.2	Information Technologies for Data Protection	3	exam
EC2.3	Modern Approaches to Designing Intelligent Buildings and Systems	3	exam
EC2.4	Designing Intelligent Systems and Devices	3	exam
EC2.5	Machine Learning Technologies	3	exam
EC2.6	Modern Technologies for Signal and Image Processing	3	exam
EC2.7	Methods of Computational Intelligence in Smart Systems	3	exam
EC2.8	Methods of Forecasting on Big Data	3	exam
EC2.9	Online Methods of Machine Learning	3	exam
EC2.10	Fast Machine Learning Tools for Data Analysis and Forecasting Tasks	3	exam
Total per cycle:		**6**	
Disciplines of free choice of the postgraduate student *			
EC3.1	Discipline of free choice of a postgraduate student	3	test
Total per cycle:		**3**	
TOTAL		43	

4. Matrix of correspondence of program competencies to educational components

	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.	EC 1.1.	EC 1.2.	EC 1.3.	EC 1.4.	EC 1.5.	EC 1.6.	EC 1.7.	EC 1.8.	EC 1.9.	EC 1.10.	EC 2.1.	EC 2.2.	EC 2.3.	EC 2.4.	EC 2.5.	EC 2.6.	EC 2.7.	EC 2.8.	EC 2.9.	EC 2.10.	EC 3.1.
INT								•			•		•			•		•		•			•							
GK1	•									•	•	•	•	•	•	•	•	•	•											
GK2		•	•							•	•	•	•	•	•	•	•	•	•											
GK3				•		•				•	•	•	•	•	•	•	•	•	•											
GK4					•					•	•	•	•	•	•	•	•	•	•											
GK5																				•		•	•	•		•		•		
GK6																					•			•		•	•			•
GK7																				•		•		•	•			•		•
PK1							•	•												•	•			•			•	•	•	
PK2									•												•	•	•		•	•		•	•	
PK3								•													•	•	•		•			•		•
PK4							•													•			•	•	•		•	•		•
PK5									•											•	•	•		•	•	•	•		•	
PK6								•														•		•			•		•	

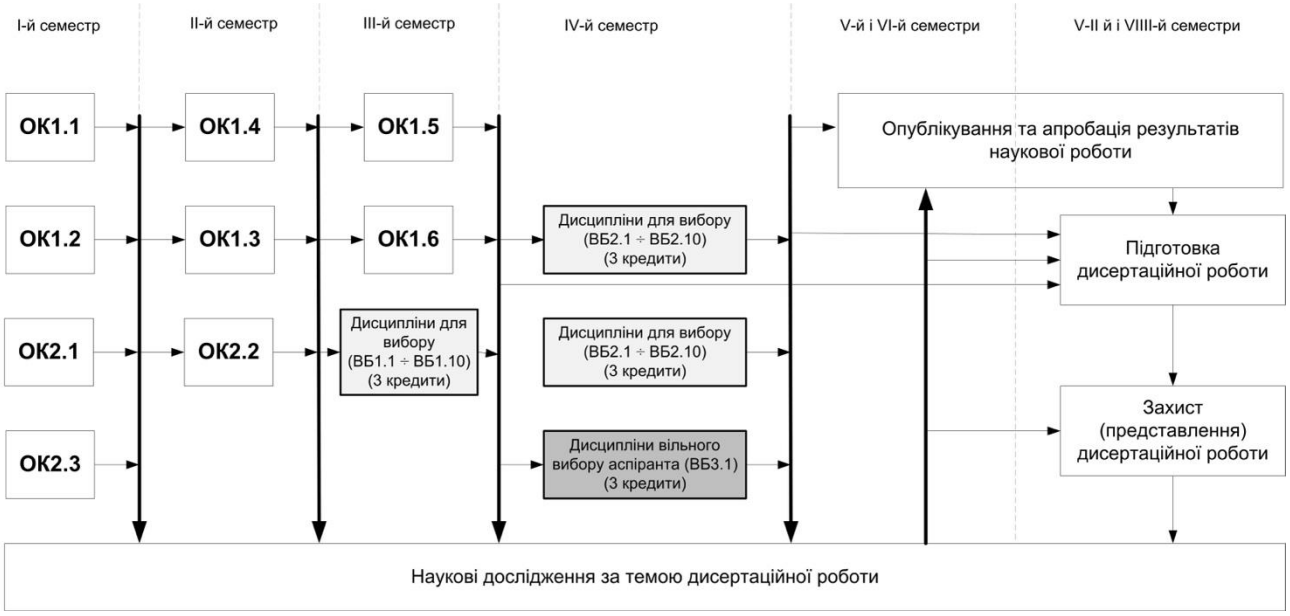
Conventional designations: MCi – mandatory course/discipline, ECi – elective course/discipline, i – course/discipline number in the list of courses/disciplines of the educational components, INT – integral competence, GKj – general competence, PKj – professional (special) competence, j – competence number in the list of competences of the educational component.

5. Matrix of ensuring program learning outcomes by corresponding components of the educational component

	MC1.1.	MC1.2.	MC1.3.	MC1.4.	MC1.5.	MC1.6.	MC2.1.	MC2.2.	MC2.3.	EC1.1	EC1.2.	EC1.3.	EC1.4.	EC1.5.	EC 1.6.	EC 1.7.	EC 1.8.	EC 1.9.	EC 1.10.	EC 2.1.	EC 2.2.	EC 2.3.	EC 2.4.	EC 2.5.	EC 2.6.	EC 2.7.	EC 2.8.	EC 2.9.	EC 2.10.	EC 3.1.
KN1								•	•	•																				
KN2	•				•			•	•	•	•			•			•	•	•	•	•	•	•				•	•	•	•
KN3	•				•			•		•	•			•			•	•	•	•	•	•	•				•	•	•	•
KN4	•				•	•	•	•	•	•	•			•					•	•			•	•			•	•		•
KH5	•			•	•	•	•						•	•	•						•	•							•	•
SK1	•				•	•	•	•		•	•			•						•									•		•
SK2	•				•	•	•	•		•	•			•			•	•	•	•	•	•	•				•	•	•	•
SK3	•				•	•	•	•	•	•	•			•					•	•			•	•			•	•		•
SK4	•			•	•	•	•						•	•	•															•
SK5	•				•			•		•	•			•					•	•			•	•	•		•	•		•
SK6		•	•			•	•					•				•										•				
COM1		•	•			•	•					•				•										•				
COM2		•	•			•	•					•				•										•				
AR1				•			•						•		•							•			•					
AR2				•			•						•									•			•					
AR3				•			•						•									•								

Conventional designations: MCi – mandatory course/discipline, ECi – elective course/discipline, i – discipline number in the list of courses/disciplines of the educational component, KNm – program results (knowledge), SKm – program results (skills), COM – program results (communication), AR – program results (autonomy and responsibility), m – program result number in the list of program results of the educational component.

6. Structural and logical scheme of the educational and scientific program of the third (educational and scientific) level of higher education in the specialty 122 "Computer Sciences"



II. Scientific component of the educational and scientific program

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

The dissertation for the degree of Doctor of Philosophy is an independent, detailed study that proposes a solution to a relevant scientific problem in the speciality 122 "Computer Science", the results of which constitute an original contribution to the body of knowledge in the speciality 122 "Computer Science" and are published in relevant publications.

The scientific component of the educational and scientific program is drawn up as an individual plan for the postgraduate student's scientific work and is an integral part of the postgraduate curriculum.

An integral part of the scientific component of the postgraduate program is the preparation and publication of scientific articles, as well as the delivery of speeches at scientific conferences, scientific professional seminars, round tables, and symposia.

Research topics
in the specialty 122 "Computer Sciences"

1. Development of information technologies and information systems for automated information processing and management.
2. Information technologies for analysis and synthesis of structural, information and functional models of automated objects and processes.
3. Models and methods of automation of functions and tasks of 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 building universal and specialised computer systems and networks, including education computerisation systems.
6. Information technologies for system analysis, research, development of architecture and methods for building multi-level, territorially distributed computer systems and networks with distributed databases and knowledge, in particular for commercial purposes.
7. Information technologies for effective development of software for computer networks and distributed data processing systems.
8. Information technologies for developing models and methods for controlling, classifying, encoding and ensuring the reliability of information, as well as for mathematical modelling of errors in data exchange paths in information telecommunication networks.

9. Modelling of subject areas of information systems (analytical, simulation, infological, object-oriented, etc.) based on the creation and application of relevant information technologies.

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

11. Information technologies for the construction and implementation of: automated technical diagnostics systems, geoinformation systems for various purposes and computer systems for electronic business.

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

13. Development and research of models and methods for assessing the quality and improving the reliability, functional safety and survivability of information and information management systems, as well as information technologies for the creation of guarantee-worthy automated information processing and management systems for critical applications.

14. Research, development and implementation of Internet technologies for the construction of service-oriented systems, as well as for the organisation and implementation of distributed information processing systems.

15. Applied software systems.

16. Instrumental software systems and methodology for developing special software.

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

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

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

20. Creation and use of abstract and natural languages for controlling calculations.

IV. Requirements for the existence of a system of internal quality assurance of higher education

Lviv Polytechnic National University operates a system for ensuring the quality of educational activities and the quality of higher education (internal quality assurance system), which provides for the implementation of the following procedures and measures:

- determining the principles and procedures for ensuring the quality of higher education;
- monitoring and periodic review of educational programs;
- annual assessment of higher education applicants, scientific and pedagogical and teaching staff of the higher educational institution and regular publication of the results of such assessments on the official website of the higher educational institution, on information stands and in any other way;
- ensuring the advanced training of pedagogical, scientific and scientific and pedagogical staff;
- ensuring the availability of necessary resources for organising the educational process, including independent work of students, for each academic program;
- ensuring the availability of information systems for effective management of the educational process;
- ensuring the publicity of information about educational programs, degrees of higher education and qualifications;
- ensuring an effective system for preventing and detecting academic plagiarism in scientific works of employees of higher education institutions and higher education applicants;
- other procedures and measures.

The system for ensuring the quality of educational activities and the quality of higher education by a higher education institution (internal quality assurance system) is assessed by the National Agency for Quality Assurance in Higher Education or by independent institutions for assessing and ensuring the quality of higher education accredited by it for its compliance with the requirements for the system for ensuring the quality of higher education, approved by the National Agency for Quality Assurance in Higher Education, and international standards and recommendations for ensuring the quality of higher education.

III. Postgraduate student certification

Certification of candidates for the degree of Doctor of Philosophy is carried out by a specialised academic council, permanently operating or established for a one-time defence, based on a public defence of scientific achievements in the form of a dissertation.

A mandatory condition for admission to the defence is the successful completion of the postgraduate student's individual curriculum.

Candidates for the degree of Doctor of Philosophy defend dissertations, as a rule, before a permanently operating specialised academic council in the relevant speciality, which operates at the higher educational institution where the postgraduate student was trained. The academic council of the higher educational institution has the right to submit documents to the National Agency for Quality Assurance in Higher Education for accreditation of the specialised academic council established for a one-time defence, or to apply with a corresponding application to another higher educational institution where a permanently operating specialised academic council in the relevant specialty operates.