

THE MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
LVIV POLYTECHNIC NATIONAL UNIVERSITY



## «ACCEPT»

Rector of

Lviv Polytechnic National University

Yurii BOBALO

24. 03. 2023

## EDUCATIONAL-PROFESSIONAL PROGRAM

## «COMPUTER SCIENCE»

## (COMPUTATIONAL INTELLIGENCE OF SMART SYSTEMS)»

## THE FIRST (BACHELOR'S) LEVEL OF HIGHER EDUCATION

FIELD OF KNOWLEDGE 12 Information Technologies

SPECIALTY 122 Computer Sciences

Considered and approved  
by Lviv Polytechnic National University  
Scientific Council

27. 12. 2023

Protocol No 89

Лviv 2023

**LETTER OF AGREEMENT  
of educational-professional program**

Level of higher education	First (Bachelor's)
Field of knowledge	12 Information Technologies
Specialty	122 Computer Sciences
Qualification	<u>Bachelor of Computer Science</u> with specialization in "Computational Intelligence of Smart Systems"

**DEVELOPED AND APPROVED**

Scientific and Methodical Commission  
of the specialty 122 "Computer Science"

Protocol No 2

21.11. 2022

The Head of the SMC of the specialty

  
Uliana MARIUTSA

**AGREED**

The Vice-Rector on scientific and  
pedagogical work of  
Lviv Polytechnic National University

  
Oleh DAVYDCHAK

14.12. 2022

**RECOMMENDED**

The scientific-methodical Council  
of the University

Protocol No 66

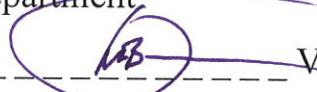
14.12. 2022

The head of the SMC of the University

  
Anatolii ZAGORODNIY

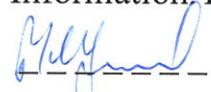
Head of educational and methodical

Department

  
Vasyl TOMYUK

14.12. 2022

Director of Educational-Scientific  
Institute of Computer Science and  
Information Technologies

  
Mykola MEDYKOVSKYY

14.12. 2022

## PREFACE

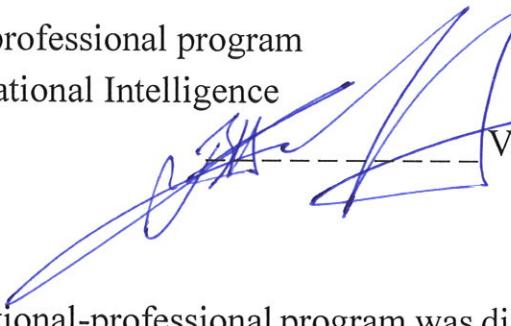
Developed by the working group of the Scientific and Methodological Commission for the specialty 122 "Computer Science" based on the Higher Education Standard for the specialty 122 "Computer Science" for the first (bachelor's) level of higher education, approved by the Order of the Ministry of Education and Science of Ukraine No. 962 dated July 10, 2019, composed of:

Vasyl TESLYUK	- Doctor of Sciences, Professor, Head of ACS Department
Ivan TSMOTS	- Doctor of Sciences, Professor, ACS Department
Iryna KAZYMYRA	- PhD, Associate Professor, ACS Department
Kvitoslava OBELOVSKA	- PhD, Associate Professor, ACS Department
Zoreslava SHPAK	- PhD, Associate Professor, ACS Department
Yurii TSYMBAL	- PhD, Associate Professor, ACS Department

The following persons were involved in the development of the program:

Yaroslav VASYLYUK	– EPAM company (employer representative)
Ihor LESHKOVYCH	– Leobit company (employer representative)
Olena ZNAK	– student (ACS department)

Guarantor of the educational-professional program  
"Computer Science (Computational Intelligence  
of Smart Systems)"



Vasyl TESLYUK

The project of the educational-professional program was discussed and approved at the meeting of the Scientific Council of the Educational-Scientific Institute of Computer Science and Information Technologies.

Protocol No 3-22/23 from 22.11. 2022

Chairman of the Scientific Council Mykola MEDYKOVSKYY

APPROVED AND ENACTED

By order of the Rector of Lviv Polytechnic National University

24.03.2023 No 121-1-10

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**2. Profile of the Educational Program**  
**"Computer Science (Computational Intelligence of Smart Systems)"**  
**in Specialty 122 "Computer Science"**

1 – General Information	
<b>The full name of the institution of higher education and the structural unit</b>	<b>Lviv Polytechnic National University</b> Institute of Computer Science and Information Technologies Department of Automated Control Systems (ACS)
<b>The level of higher education</b>	The first (Bachelor's) level
<b>Ступінь вищої освіти</b>	Bachelor
<b>Field of knowledge:</b>	12 Information Technologies
<b>Specialty</b>	122 Computer Science
<b>Official name of the educational programme</b>	Computer Science (Computational Intelligence of Smart Systems)
<b>Educational qualification</b>	Bachelor in Computer Science
<b>Qualification in diploma</b>	Level of higher education – Bachelor Specialty – 122 Computer Sciences Educational program – Computer Science (Computational Intelligence of Smart Systems)
<b>Type of diploma and duration of study</b>	Bachelor's Degree Diploma, single, duration of study – 3 years 10 months
<b>Programme volume</b>	The volume of the Bachelor's educational programme based on complete general secondary education is 240 ECTS credits. Based on the educational degree "Junior Bachelor", the higher education institution has the right to recognize and reallocate ECTS credits obtained within the previous educational programme in the specialty 122 Computer Science – no more than 120 ECTS credits; in other specialties – no more than 60 ECTS credits. At least 50% of the program volume must be aimed at ensuring the general and professional (subject-specific) competencies in the specialty, as defined by the Higher Education Standard.
<b>The availability of accreditation</b>	-
<b>Cycle/Level</b>	NQF of Ukraine – Level 6, FQ-EHEA – First cycle, QF-LLL – Level 6
<b>Entry requirements</b>	Complete general secondary education
<b>Language (s) of teaching</b>	Ukrainian
<b>Restrictions on forms of education</b>	Missing
<b>Basic concepts and their definitions</b>	The program uses the key concepts and their definitions in accordance with the Law of Ukraine "On Higher Education" and the Higher Education Standard of Ukraine: first (bachelor's) level, field of knowledge – 12 Information Technology, specialty – 122 Computer Science.
2 - Purpose of the Educational Program	
	To provide students with theoretical knowledge, practical skills, and competencies sufficient for the successful performance of professional duties in the specialty 122 "Computer Science", and to prepare them for further education and employment in their chosen specialization within the field of computer science and information technology.

3 - Characteristics of the Educational Program	
<b>Subject area description</b>	<p><i>Objects of study and/or professional activity:</i> mathematical, informational, and simulation models of real-world phenomena, objects, systems, and processes; data and knowledge representation; methods and technologies for acquiring, storing, processing, transmitting, and utilizing information; intelligent data analysis and decision-making; theory, analysis, development, efficiency assessment, and implementation of algorithms; high-performance computing, including parallel computing and big data.</p> <p><i>Learning objectives:</i> to train professionals capable of conducting theoretical and experimental research in computer science; applying mathematical methods and algorithmic principles in modeling, designing, developing, and maintaining information technologies; developing, implementing, and supporting intelligent systems for data analysis and processing in organizational, technical, natural, and socio-economic systems.</p> <p><i>Theoretical content of the subject area:</i> modern models, methods, algorithms, technologies, processes, and techniques for acquiring, representing, processing, analyzing, transmitting, and storing data in information systems.</p> <p><i>Methods, methodologies, and technologies:</i> mathematical models, methods, and algorithms for solving theoretical and applied problems arising in IT development; modern programming technologies and platforms; methods of collecting, analyzing, and consolidating distributed information; technologies and methods for designing, developing, and ensuring the quality of IT components; methods of computer graphics and data visualization; knowledge engineering technologies, CASE-technologies for modeling and designing IT; business analysis and data analytics technologies.</p> <p><i>Tools and equipment:</i> distributed computing systems; computer networks; mobile and cloud technologies; database management systems; operating systems.</p>
<b>Program orientation</b>	General higher education at the first (bachelor's) level in the field of Information Technology, specialty 122 "Computer Science". The educational and professional program is based on widely recognized scientific results and takes into account the current state of development in the IT industry. The research track is professionally oriented; the expert track is practice-oriented.
<b>Main focus of the program and specialization</b>	<p>The educational and professional program is aimed at training specialists capable of solving complex problems of modeling processes and systems of various nature, forecasting, design, optimization, systems analysis and decision-making, data and knowledge analysis and synthesis. It also focuses on the application of computational intelligence methods, software systems and IT development, as well as smart systems and intelligent technologies.</p> <p><i>Key words:</i> computer science, computational intelligence, smart systems, neural network technologies, information control systems.</p>
<b>Distinctive features and competitive advantages</b>	A key feature of the program is the training of specialists capable of developing and implementing smart systems and intelligent control technologies in various application domains, grounded in in-depth knowledge of the theory and methods of computational intelligence, neural network technologies, and the specifics of modelling and controlling smart systems.

	<p>The educational program includes <b>two study tracks</b>:</p> <ul style="list-style-type: none"> <li>- <b>Computational Intelligence and Smart Systems</b> – in-depth study of the foundations of computational intelligence, soft computing models and methods, neural network technologies, principles of smart system design and modelling, and innovative smart technologies applicable across industries.</li> <li>- <b>Information Control Systems and Technologies</b> – comprehensive study of the architecture of information control systems, fundamentals of control theory and telecommunication information technologies, sensors and interfaces for control systems, digital signal processing; ability to model systems and processes and design experiments to acquire new knowledge.</li> </ul> <p>The program includes classroom involvement of industry professionals, field experts, and employer representatives. Selected courses are delivered in English. The program also provides opportunities for academic mobility.</p>
<b>4 – Employability and Further Education Opportunities of Program Graduates</b>	
<b>Employability</b>	<p>Professional activity as a specialist in the field of information technology, smart systems, and computational intelligence, including employment in IT companies, development of mathematical, informational, and software components of information systems, design of smart systems, and implementation of intelligent (smart) technologies.</p> <p>Graduates may hold positions in accordance with the National Classifier of Professions of Ukraine, such as: information technology specialist; software development and testing specialist; computer programmer, etc.</p>
<b>Further education opportunities</b>	<p>Graduates are eligible to continue their studies in the second-cycle higher education programs (Master's degree), either academic (educational-scientific) or professional (educational-professional). Additional qualifications may also be obtained through postgraduate education, professional development programs, and adult learning systems.</p>
<b>5 – Teaching and Assessment</b>	
<b>Teaching and learning methods</b>	<p>Lectures, practical classes, coursework assignments, laboratory work, independent study based on textbooks, manuals, and lecture notes, consultations with academic staff, and preparation of the bachelor's qualification work.</p>
<b>Assessment methods</b>	<p>Written and oral examinations, laboratory reports, coursework, oral presentations, and defense of the bachelor's qualification work.</p> <p>Student academic performance is assessed using the national grading scale (excellent, good, satisfactory, unsatisfactory), the 100-point scale, and the ECTS grading scale (A, B, C, D, E, FX, F) in accordance with the "Regulations on the Rating Assessment of Student Performance" of Lviv Polytechnic National University.</p>
<b>6 – Program Competencies</b>	
<b>Integral competency (INT)</b>	<p>The ability to solve complex specialized tasks and practical problems in the field of Computer Science or during the learning process, which involves the application of theories and methods of information technologies and is characterized by complexity and uncertainty of conditions.</p>
<b>General competencies (GC)</b>	<p>GC1. Ability to think abstractly, analyze, and synthesize. GC2. Ability to apply knowledge in practical situations.</p>

	<p>GC3. Knowledge and understanding of the subject area and of the professional activity.</p> <p>GC4. Ability to communicate in the state language both orally and in writing.</p> <p>GC5. Ability to communicate in a foreign language.</p> <p>GC6. Ability to learn and acquire modern knowledge.</p> <p>GC7. Ability to search for, process, and analyze information from various sources.</p> <p>GC8. Ability to generate new ideas (creativity).</p> <p>GC9. Ability to work in a team.</p> <p>GC10. Ability to be critical and self-critical.</p> <p>GC11. Ability to make well-grounded decisions.</p> <p>GC12. Ability to assess and ensure the quality of performed work.</p> <p>GC13. Ability to act based on ethical considerations.</p> <p>GC14. Ability to exercise one's rights and responsibilities as a member of society, to realize the values of a free democratic society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.</p> <p>GC15. Ability to preserve and augment moral, cultural, scientific values and achievements of society, based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society, and in the development of society, technology, and engineering; ability to use various types and forms of physical activity for active recreation and a healthy lifestyle.</p> <p>GC16. Ability to understand physical laws and regularities, the related directions of scientific development, and the preconditions for the emergence of new technologies.</p> <p>GC17. Ability to analyze tasks, objects, and systems of various purposes, and to formulate goals and objectives for their solution or implementation.</p> <p>GC18. Ability to think algorithmically and to structure information.</p> <p>GC19. Ability to make decisions and act in compliance with the principle of zero tolerance for corruption and any other forms of misconduct or lack of integrity.</p>
<p><b>Program-specific (professional) competencies (PC)</b></p>	<p>PC1. Ability to mathematically formulate and study continuous and discrete mathematical models, justify the choice of methods and approaches for solving theoretical and applied problems in computer science, analyze and interpret results.</p> <p>PC2. Ability to identify statistical patterns of non-deterministic phenomena, apply computational intelligence methods, including statistical, neural network, and fuzzy data processing, machine learning methods, genetic programming, etc.</p> <p>PC3. Ability for logical reasoning, building logical inferences, using formal languages and models of algorithmic computation, designing, developing, and analyzing algorithms, assessing their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modeling of subject domains and development of software and information systems.</p> <p>PC4. Ability to use modern methods of mathematical modeling of objects, processes, and phenomena; develop models and algorithms for numerical solution of modeling problems; take into account the errors of approximate solutions to professional problems.</p> <p>PC5. Ability to formalize operations research problems in organizational-technical and socio-economic systems of various</p>

purposes, determine optimal solutions, build models of optimal control considering changes in the economic environment, and optimize management processes in systems of various purposes and levels of hierarchy.

PC6. Ability for systems thinking, applying systems analysis methodology to study complex problems of various nature, methods of formalization and solution of systems problems with conflicting goals, uncertainty, and risks.

PC7. Ability to apply theoretical and practical foundations of modeling methodology and technology to study characteristics and behavior of complex objects and systems, conduct computational experiments, and process and analyze results.

PC8. Ability to design and develop software using various programming paradigms: generic, object-oriented, functional, logical, with appropriate models, methods and algorithms of computation, data structures, and control mechanisms.

PC9. Ability to implement a multi-tier computational model based on client-server architecture, including databases, knowledge bases, and data warehouses; perform distributed processing of large datasets on standard server clusters, including using cloud services.

PC10. Ability to apply methodologies, technologies, and tools for managing the life cycle of information and software systems, IT products, and services in accordance with customer requirements.

PC11. Ability to perform intelligent data analysis using computational intelligence methods, including big and poorly structured data, real-time processing, and visualization of analysis results in solving applied problems.

PC12. Ability to organize computing processes in information systems of various purposes, taking into account architecture, configuration, and performance indicators of operating systems and system software.

PC13. Ability to develop network software operating based on various structured cabling system topologies, use computer systems and data transmission networks, and analyze network performance.

PC14. Ability to apply methods and tools of information security, develop and operate specialized software to protect information resources of critical information infrastructure objects.

PC15. Ability to analyze and functionally model business processes, build and practically apply functional models of organizational-economic and production-technical systems, and evaluate risks in their design.

PC16. Ability to implement high-performance computing using cloud services and technologies, parallel and distributed computing in the development and operation of distributed information processing systems.

PC17. Ability to apply computational intelligence theory and methods for modeling and designing smart systems and intelligent control systems in various fields.

PC18. Ability to use neural network technologies in the development of intelligent control and smart systems.

PC19. Ability to develop smart technologies for various purposes.

PC20. Ability to design smart systems and their components for various application domains.

	<p>PC21. Ability to comprehend professional literature and prepare technical documentation in English; communicate in English in the course of professional duties.</p> <p>PC22. Ability to understand occupational safety requirements in the IT field and ensure safe working conditions (personal and team) at the workplace.</p>
<p><b>Professional subject-oriented competencies (PSC)</b></p>	<p><b>1. Track “Computational Intelligence and Smart Systems”:</b></p> <p>PCS1.1. Ability to develop smart system interfaces and program mobile smart systems.</p> <p>PCS1.2. Ability to apply knowledge of digital signal and image processing for the development of augmented and virtual reality systems and in solving applied problems.</p> <p>PCS1.3. Ability to model smart systems, ensure their reliability, and develop technologies for smart enterprises.</p> <p>PCS1.4. Ability to apply cloud technologies and services as well as Internet of Things (IoT) technologies in solving applied problems.</p> <p>PCS1.5. Ability to apply knowledge of control theory and decision-making processes in the design of smart systems.</p> <p>PCS1.6. Ability to assess the risks associated with the use of artificial intelligence and apply technologies and standards for the protection of personal data.</p> <p><b>2. Track “Information Control Systems and Technologies”:</b></p> <p>PCS2.1. Ability to model control systems and apply theoretical foundations of control to develop information control systems and their components.</p> <p>PCS2.2. Ability to develop decision support systems and intelligent and distributed control systems in various fields.</p> <p>PCS2.3. Ability to apply methods and tools of modern information and telecommunication technologies and artificial intelligence systems to control processes and systems.</p> <p>PCS2.4. Ability to solve tasks related to the automated design of complex objects and systems.</p> <p>PCS2.5. Ability to apply knowledge of digital signal processing in the development of computer vision systems and information control systems and their components.</p> <p>PCS2.6. Ability to perform reliability calculations for information control systems and their components.</p>
	<p style="text-align: center;"><b>7 – Program Learning Outcomes</b></p> <p><b>Program learning outcomes (PLO)</b></p> <p>PLO1. Apply knowledge of the fundamental forms and laws of abstract-logical reasoning, basics of scientific inquiry methodology, and methods of information extraction, analysis, processing, and synthesis within the domain of computer science.</p> <p>PLO2. Apply modern mathematical tools of continuous and discrete analysis, linear algebra, and analytical geometry in professional activities to solve theoretical and applied problems in designing and implementing information systems.</p> <p>PLO3. Apply knowledge of the patterns and properties of random phenomena, stochastic process models, and modern software tools to solve tasks involving statistical data analysis and predictive modelling.</p> <p>PLO4. Use computational intelligence methods, including machine learning, neural networks, fuzzy logic, genetic, and evolutionary programming, to solve recognition, prediction, classification, and control identification tasks.</p>

PLO5. Design, develop, and analyze algorithms for computational and logical problem-solving; assess algorithm efficiency and complexity using formal models of algorithms and computable functions.

PLO6. Apply numerical methods for differentiation and integration, solve ordinary differential and integral equations, and implement numerical methods in software for engineering and scientific tasks.

PLO7. Understand and apply principles of modelling organizational and technical systems and operations; use operations research methods to solve single- and multi-criteria optimization problems in linear, integer, nonlinear, and stochastic programming.

PLO8. Apply systems analysis methodology to analyze, forecast, control, and design dynamic processes in macroeconomic, technical, technological, and financial systems.

PLO9. Develop software models of subject domains; select appropriate programming paradigms for implementing methods and algorithms in computer science problem-solving.

PLO10. Use tools for developing client-server applications; design conceptual, logical, and physical database models; optimize queries; create distributed databases, data warehouses, and knowledge bases using cloud services and web technologies.

PLO11. Manage the life cycle of software products and IT services in accordance with customer requirements and constraints; prepare project documentation such as feasibility studies, technical specifications, business plans, and contracts.

PLO12. Apply computational intelligence and data mining methods for classification, prediction, clustering, and association rule discovery using multidimensional data analysis tools (Data Mining, Text Mining, Web Mining).

PLO13. Demonstrate knowledge and practical skills in system programming, network technologies, and computer network administration, including network architectures and software tools.

PLO14. Apply design methodologies and CASE tools for developing complex systems; use structural systems analysis and object-oriented design methods for creating and researching functional models of organizational and production systems.

PLO15. Understand the principles of information security and secure software design; ensure the protection of computer networks under conditions of incomplete or uncertain input data.

PLO16. Perform parallel and distributed computing; apply numerical methods and algorithms using parallel structures and programming languages for developing and maintaining parallel and distributed software.

PLO17. Demonstrate knowledge of the fundamentals of anti-corruption policy, social and academic integrity; promote intolerance to corruption and dishonest behaviour, and apply these principles in professional activities.

#### **Distinctive features of the program**

PLO18. Demonstrate knowledge of the theory and methods of computational intelligence, the principles of quantum computing, and quantum optimization methods, and apply them to the development of smart systems and information control systems in specific application domains.

	<p>PLO19. Develop smart technologies and design intelligent and control systems for various application domains using neural network and machine learning technologies.</p> <p>PLO20. Use communication skills in the state and foreign languages to present results, interpret professional literature, and prepare technical documentation in Ukrainian and English; communicate effectively in English while performing professional duties in the IT field.</p> <p>PLO21. Demonstrate understanding of occupational safety requirements in the IT field; maintain safe working conditions, collaborate effectively in a team, adhere to professional ethics, and uphold moral, ethical, and civic values in professional activities.</p>
	<p><b>1. Track “Computational Intelligence and Smart Systems”</b></p> <p>PLO1.1. Design and program mobile and embedded smart systems and user interfaces; apply cloud technologies, services, and Internet of Things (IoT) technologies in smart system development.</p> <p>PLO1.2. Apply knowledge of digital signal and image processing in the design and development of smart technologies, including virtual and augmented reality systems.</p> <p>PLO1.3. Model processes within smart systems and develop simulation models of smart systems, including smart enterprises.</p> <p>PLO1.4. Apply knowledge of control theory and decision-making methods in the design of smart systems; ensure their reliability, resilience, and security.</p> <p>PLO1.5. Understand and apply personal data protection standards (e.g., GDPR); assess and mitigate risks associated with the use of artificial intelligence technologies.</p> <p><b>2. Track “Information Control Systems and Technologies”</b></p> <p>PLO2.1. Develop information and telecommunication control technologies and perform automated system or object design for applications across various industries.</p> <p>PLO2.2. Apply control theory in the development of information control systems and their components; create system control models and simulate processes within such systems.</p> <p>PLO2.3. Design and implement decision support systems and artificial intelligence components for information management technologies across diverse domains.</p> <p>PLO2.4. Apply digital signal processing methods to solve problems related to computer vision and information control system development.</p> <p>PLO2.5. Design intelligent and distributed control systems and ensure the reliability and security of their components and the system as a whole.</p>
<b>8 – Resource Support for Programme Implementation</b>	
<b>Key characteristics of human resources</b>	<p>The composition of the project team of the educational programme and the teaching staff involved in its delivery complies with the Licensing Conditions for Educational Activity at the First (Bachelor's) Level of Higher Education.</p> <p>90% of academic staff involved in teaching professionally-oriented courses within specialty 122 "Computer Science" hold academic degrees and titles, and 40% have practical professional experience in the field.</p>

<b>Key characteristics of material and technical support</b>	Educational buildings; computer classrooms; specialized laboratories (computer circuit design, hardware and software tools of automated control systems, computer information processing and control systems, distributed information systems, mobile robotic systems); multimedia equipment; software tools; wireless Internet access points; libraries and reading rooms; student dormitories; dining facilities; sports complex and athletic fields.
<b>Key characteristics of information and methodological support</b>	The virtual learning environment of Lviv Polytechnic National University; the official university website; academic and working curricula; academic calendars; teaching and learning support packages for disciplines; course syllabi and working programmes; internship programmes; methodological guidelines for practical, laboratory, course works and bachelor's qualification project; textbooks and manuals approved by the Academic Council of Lviv Polytechnic National University; materials from educational platforms such as edX, Prometheus, and others.
<b>9 – Academic Mobility</b>	
<b>National credit mobility</b>	Based on bilateral agreements between Lviv Polytechnic National University and other Ukrainian higher education institutions.
<b>International credit mobility</b>	Based on bilateral agreements between Lviv Polytechnic National University and partner higher education institutions abroad.
<b>Education of international students</b>	The admission of international students is possible. The conditions of admission and the organization of the educational process are determined by the Regulations on the Education of Foreign Citizens at Lviv Polytechnic National University.

**2. Distribution of the content of the educational-professional program  
by component groups and training cycles**

No	Cycle of training	Educational workload of a student (credits / %)		
		Mandatory components	Elective components	Total for the entire period of training
1	2	3	4	5
1.	Cycle of general training	<b>74 / 30,8</b>	<b>6 / 2,5</b>	<b>80 / 33,3</b>
2.	Cycle of professional training	<b>106 / 44,2</b>	<b>54 / 22,5</b>	<b>160 / 66,7</b>
Total for the entire period of training		<b>180 / 75</b>	<b>60 / 25</b>	<b>240 / 100</b>

### 3. List of components of educational-professional program

	Components of the educational program	Number of credits ECTS	Form of final control
1	2	3	5
<b>Mandatory components (MC) of the educational-professional program</b>			
<i>1. Cycle of general training</i>			
MC1	Foreign Language (for Professional Purposes) (part 1, 2, 3)	9	exam
MC2	History of Ukrainian Statehood and Culture	3	exam
MC3	Ukrainian Language (for Professional Purposes)	3	test
MC4	Philosophy	3	exam
MC5	Algebra and Geometry	6	exam
MC6	Mathematical Analysis	6	exam
MC7	Probability Theory and Mathematical Statistics	5	test
MC8	Discrete Mathematics	6	exam
MC9	Numerical Methods	5	exam
MC10	Operations Research	5	exam
MC11	Physics	5	test
MC12	Fundamentals of Programming	7	exam
MC13	Algorithms and Data Structures	6	exam
MC14	Systems Analysis	5	exam
<b>Total for the cycle:</b>		<b>74</b>	
<i>2. Cycle of professional training</i>			
MC15	Object-Oriented Programming (6) incl. Coursework (2)	8	exam test
MC16	Applied Programming (5) incl. Coursework (2)	7	exam test
MC17	Principles of Computer Organization	6	exam
MC18	Operating Systems	4	test
MC19	Computer Networks	4	exam
MC20	Database and Knowledge Base Organization	6	exam
MC21	Web Technologies and Web Applications Development (4) incl. Coursework (2)	6	exam test
MC22	Information Security	4,5	test
MC23	Data Mining	4	exam
MC24	Parallel Computing and Distributed Systems	4	test
MC25	Information Systems Design (5) incl. Coursework (2)	7	exam test
MC26	IT Project Management	5	exam
MC27	Theory and Methods of Computational Intelligence	5	exam
MC28	Fundamentals of Smart Technologies and Systems	4	exam
MC29	Neural Network Technologies and Systems	5	exam
MC30	Teamwork and Presentation Skills in the IT Industry	4	test
MC31	English for the IT Industry	3	test
MC32	Fundamentals of Occupational Health and Life Safety	3	test
MC33	Project and Technological Internship	3	test
MC34	Internship Related to the Bachelor's Qualification Work	4,5	test
MC35	Bachelor's Qualification Work	6	

<i>MC36</i>	Defense of the Bachelor's Qualification Work	3	
	<b>Total for the cycle:</b>	<b>106</b>	
	<b>Total for mandatory components:</b>	<b>180</b>	

**Elective components (EC) of the educational-professional program**

*1. Cycle of general training*

<b>Total for the cycle:</b>	<b>6</b>	test
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*2. Cycle of professional training*

***Elective block 0100 Computational intelligence and smart systems***

<i>EC11</i>	Programming of Mobile Smart Systems	4	test
<i>EC12</i>	Simulation of Processes and Smart Systems	5	exam
<i>EC13</i>	Systems of Virtual and Augmented Reality	5	exam
<i>EC14</i>	Information Technologies for Smart Enterprises	5	exam
<i>EC15</i>	Digital Signal and Image Processing Technologies	5	exam
<i>EC16</i>	Fundamentals of Control Theory and Decision Making	4	test
<i>EC17</i>	IoT Technologies and Smart Systems Interfaces	5	exam
<i>EC18</i>	Cloud Technologies and Services	5	exam
<i>EC19</i>	Fundamentals of Smart Systems Reliability	4	test
<i>EC20</i>	Data Protection Technologies and Standards	3	test
<i>EC21</i>	Trustworthy AI: the European Approach	3	test
<b>Total:</b>		<b>48</b>	

***Elective block 0200 Information control systems and technologies***

<i>EC22</i>	Information and Telecommunication Control Technologies	5	exam
<i>EC23</i>	Fundamentals of Automated Design of Systems and Objects	6	test
<i>EC24</i>	Theoretical Foundations of Control	4	test
<i>EC25</i>	Computer Vision Systems	5	exam
<i>EC26</i>	Decision Support Systems	4	test
<i>EC27</i>	Digital Signal Processing	6	exam
<i>EC28</i>	Intelligent and Distributed Control Systems	5	exam
<i>EC29</i>	Fundamentals of Reliability Theory	4	test
<i>EC30</i>	Modelling of Control Systems	5	exam
<i>EC31</i>	Artificial Intelligence Systems	4	exam
<b>Total:</b>		<b>48</b>	

***Elective components of the other educational-professional programs***

<b>Total:</b>	<b>6</b>	test
<b>Total for the cycle of professional training:</b>	<b>54</b>	
<b>Total for elective components:</b>	<b>60</b>	
<b>Total for educational-professional program:</b>	<b>240</b>	

#### **4. Form of Certification of Higher Education Applicants**

The certification is carried out in the form of the defense of a bachelor's qualification work.

The qualification work must include theoretical, system-engineering, or experimental research of a complex specialized task or practical problem in the field of computer science, characterized by complexity and uncertainty of conditions, and requiring the application of theories and methods of information technologies, computational intelligence, and innovative smart system technologies.

The qualification work must not contain academic plagiarism, falsification, or fabrication.

The qualification work must be published on the official website of Lviv Polytechnic National University, or the Educational and Scientific Institute of Computer Science and Information Technologies, or in the institutional repository.

## 5. Matrix of Correspondence between Program Competencies and Educational Program Components

		General competencies																		
		INT	GC1	GC2	GC3	GC4	GC5	GC6	GC7	GC8	GC9	GC10	GC11	GC12	GC13	GC14	GC15	GC16	GC17	GC18
MC1	+						+	+	+											
MC2	+							+	+								+	+		
MC3	+		+		+			+	+								+	+		
MC4	+	+						+	+			+				+	+	+		+
MC5	+	+					+													
MC6	+	+					+													
MC7	+	+					+													
MC8	+	+					+													
MC9	+	+					+													
MC10	+	+					+													
MC11	+	+					+										+	+		
MC12	+	+	+	+			+	+	+										+	+
MC13	+	+					+	+												+
MC14	+	+		+			+	+	+		+	+	+				+	+	+	
MC15	+	+	+	+			+	+	+											
MC16	+	+	+	+			+	+	+					+						
MC17	+	+					+	+											+	
MC18	+	+					+	+												
MC19	+	+					+	+												
MC20	+	+					+	+												+
MC21	+	+	+	+			+	+	+											
MC22	+	+					+	+			+					+				
MC23	+	+					+	+	+											
MC24	+	+					+	+												
MC25	+	+	+	+			+	+	+					+						+
MC26	+	+	+	+	+		+	+	+	+	+	+	+	+	+					
MC27	+	+					+	+						+						+
MC28	+	+					+	+						+						+
MC29	+	+					+	+						+						+
MC30	+	+					+	+	+		+	+	+							
MC31	+					+	+	+												
MC32	+			+			+	+									+	+		+
MC33	+	+	+	+	+		+	+			+	+		+	+					
MC34	+	+	+	+	+		+	+	+	+	+	+	+	+	+					
MC35	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					+
MC36	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					

	Program-specific (professional) competencies (PC)																					
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17	PC18	PC19	PC20	PC21	PC22
MC1																						+
MC2																						
MC3																						
MC4																						
MC5	+																					
MC6	+																					
MC7	+	+																				
MC8	+		+																			
MC9				+	+																	
MC10						+																
MC11																						
MC12			+						+													
MC13			+	+		+			+													
MC14	+	+				+												+				
MC15									+													
MC16									+													
MC17										+	+						+					
MC18																	+	+				
MC19										+							+	+				
MC20											+											
MC21											+											
MC22																						
MC23																						
MC24											+											
MC25		+										+	+									
MC26												+										
MC27	+												+							+		
MC28																		+	+		+	+
MC29		+	+															+	+			+
MC30						+												+				+
MC31																						+
MC32																						+
MC33	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC34	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC35	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC36	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

## Components of the elective blocks of the educational program

	Professional subject-oriented competencies (PSC)											
	PSC 1.1	PSC 1.2	PSC 1.3	PSC 1.4	PSC 1.5	PSC 1.6	PSC 2.1	PSC 2.2	PSC 2.3	PSC 2.4	PSC 2.5	PSC 2.6
EC11	+											
EC12			+									
EC13		+										
EC14			+									
EC15		+										
EC16					+							
EC17	+			+								
EC18				+								
EC19			+									
EC20						+						
EC21						+						
EC22									+			
EC23										+		
EC24						+						
EC25											+	
EC26								+				
EC27										+		
EC28								+				
EC29												+
EC30						+						
EC31									+			

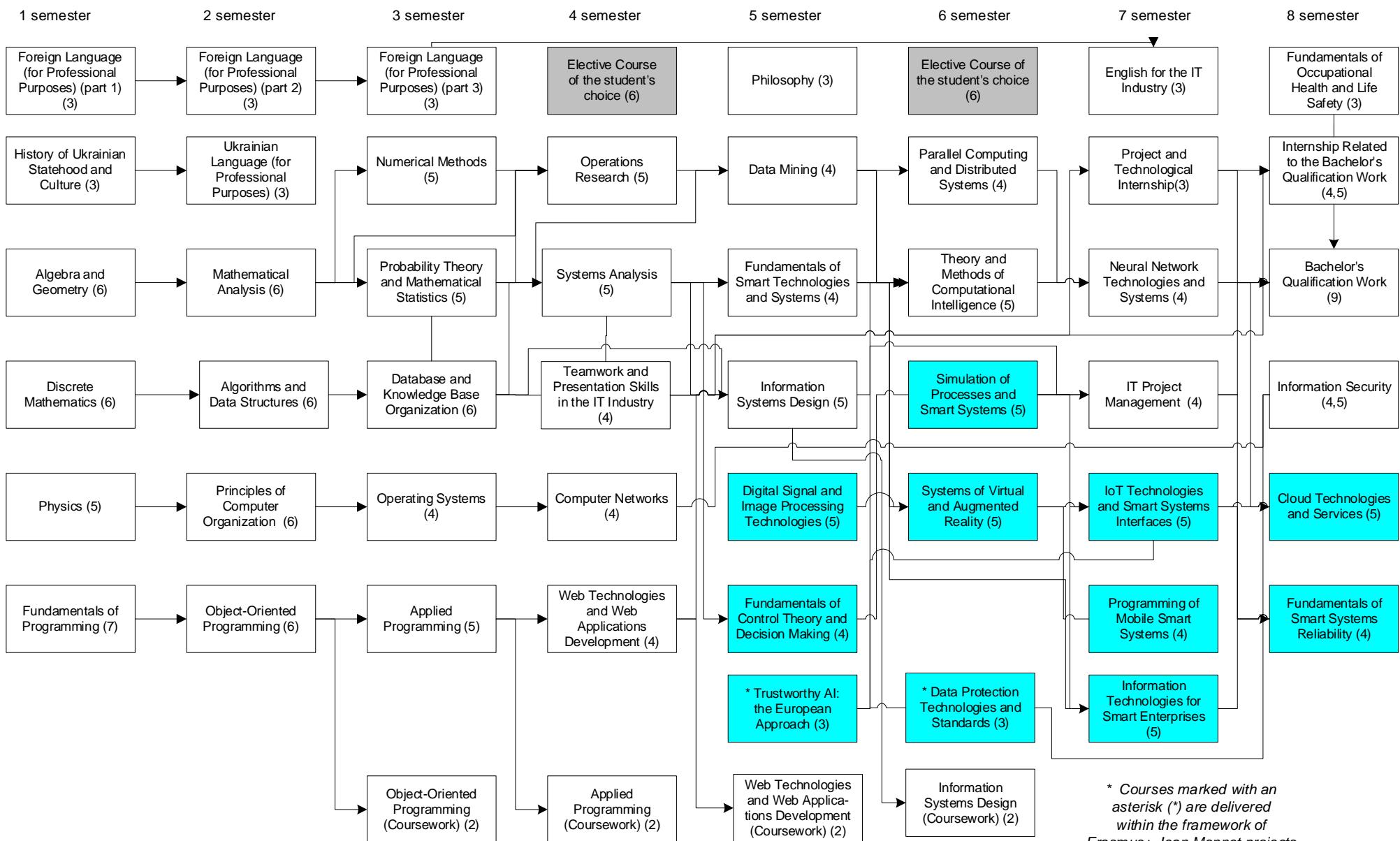
## 6. Matrix of the Provision of Program Learning Outcomes by the Educational Program Components

	Program learning outcomes (PLO)																				
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	PLO13	PLO14	PLO15	PLO16	PLO17	PLO18	PLO19	PLO20	PLO21
MC1																					+
MC2																					+
MC3																					+
MC4	+																				+
MC5		+																			+
MC6		+																			
MC7		+	+																		
MC8		+			+																
MC9						+															
MC10							+														
MC11	+																				
MC12											+										
MC13					+						+										+
MC14	+	+						+													+
MC15											+										
MC16											+										
MC17																	+				
MC18																		+			
MC19																		+	+		
MC20												+									
MC21												+									
MC22																				+	
MC23			+																		
MC24												+								+	
MC25													+								
MC26													+								+
MC27				+																	+
MC28																				+	+
MC29						+															+
MC30								+													+
MC31																					+
MC32																					+
MC33	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC34	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC35	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MC36	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

## Components of the elective blocks of the educational program

	Program learning outcomes (PLO)									
	PLO 1.1	PLO 1.2	PLO 1.3	PLO 1.4	PLO 1.5	PLO 2.1	PLO 2.2	PLO 2.3	PLO 2.4	PLO 2.5
EC 11	+									
EC 12			+							
EC 13		+								
EC 14			+							
EC 15		+								
EC 16				+						
EC 17	+									
EC 18	+									
EC 19				+						
EC 20					+					
EC 21					+					
EC 22						+				
EC 23						+				
EC 24							+			
EC 25								+		
EC 26								+		
EC 27								+		
EC 28									+	
EC 29									+	
EC 30						+				
EC 31							+			

**Structural and Logical Scheme of Bachelor's Training in Specialty 122 "Computer Science"  
under the Educational and Professional Program (EPP) "Computer Science (Computational Intelligence of Smart Systems)"  
with Elective Block 0100 "Computational Intelligence and Smart Systems"**



\* Courses marked with an asterisk (\*) are delivered within the framework of Erasmus+ Jean Monnet projects

**Structural and Logical Scheme of Bachelor's Training in Specialty 122 "Computer Science"  
under the Educational and Professional Program (EPP) "Computer Science (Computational Intelligence of Smart Systems)"  
with Elective Block 0200 "Information Control Systems and Technologies"**

