

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

ORDER

City of Kyiv

10.07.2019

#962

On the Approval of the Standard
of Higher Education in the Specialty
221 "Computer Sciences" For the First
(Bachelor's) Level of Higher Education.

In accordance with part six of Article 10, subparagraph 16 of part one of Article 13 of the Law of Ukraine "On Higher Education," with the Regulation on the Ministry of Education and Science of Ukraine approved by the Resolution of the Cabinet of Ministers of Ukraine of October 16, 2014 #630, taking into account the Recommended Practice for the Development of Higher Education Standards approved by the Order of the Ministry of Education and Science of Ukraine of June 1, 2016 #600 (as amended by the Order of the Ministry of Education and Science of Ukraine of December 21, 2017 #1648),

I HEREBY ORDER:

1. To approve the Higher Education Standard in the specialty 122 "Computer sciences" of the field of knowledge 12 "Information technologies" for the first (Bachelor's) higher education level that is annexed.
2. To establish that the Higher Education Standard approved by paragraph 1 of this Order is brought into force from the academic year 2019/2020 on.
3. To entrust the control over the implementation of this Order to the Deputy Minister Rashkevych, Yu. M.

Minister

(signature)

L. M. Hrynevych



APPROVED

Order of the Ministry of
Education and Science of
Ukraine of 10.07.2019 # 962

HIGHER EDUCATION STANDARD OF UKRAINE

HIGHER EDUCATION LEVEL

First (bachelor's)_level

(higher education level name)

HIGHER EDUCATION DEGREE

Bachelor

(higher education degree name)

FIELD OF KNOWLEDGE

12 Information technologies

(field of knowledge reference number and name)

SPECIALTY

122 Computer sciences

(specialty
code and
name)

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MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

**Kyiv
2019**



I. Preamble

Higher Education Standard of Ukraine of the first (bachelor's) level of the degree "bachelor" in the field of knowledge 12 "Information technologies" specialty 122 "Computer sciences"

Approved and put into effect by the order of the Ministry of Education and Science of Ukraine of July 10, 2019 #962

DEVELOPERS OF THE STANDARD

The Standard was developed by the Subcommittee 122 Computer Science of the Scientific and Methodological Committee 8 on Information Technology, Automation and Telecommunications in the following composition:

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Subach, Ihor Yuriyovych, Doctor of Technical Sciences, Associate Professor, Head of the Subdepartment of Combat Use of Mathematical Support and Software of Automated Control Systems of the Military Institute of Telecommunications and Informatization


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Yaroshko, Serhiy Adamovych,  Candidate of Physical and Mathematical Sciences, Head of the Subdepartment of Programming of Ivan Franko National University of Lviv

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Zholtkevych, Hryhoriy Mykolayovych, Doctor of Technical Sciences, Full Professor, Dean of the Department of Mathematics and Informatics of V. N. Karazin Kharkiv National University

The Standard was considered and approved at a meeting of the Subcommittee 122 Computer Sciences of the Scientific and Methodological Committee 8 on Information Technology, Automation and Telecommunications on October 25, 2016, Record #2/2016.

The Standard was considered and approved at a meeting of the Higher Education Sector of the Scientific and Methodological Council of the Ministry of Education and Science of Ukraine on November 22, 2016, Record #9.

Professional examination was carried out by:

Zadiraka, Valeriy Kostyantynovych, Head of the Division of Optimization of Computational Methods of the Institute of Cybernetics of the National Academy of Sciences of Ukraine, Academician of the National Academy of Sciences of Ukraine, Doctor of Physical and Mathematical Sciences, Full Professor.

Fedorovych, Oleh Yevhenovych, Head of the Subdepartment of Information Control Systems of M. E. Zhukovskiy National Aerospace University "Kharkiv Aviation Institute," Doctor of Technical Sciences, Full Professor.

Koshkin, Kostyantyn Viktorovych, Director of the Educational and Scientific Institute of Computer and Scientific-Technological Sciences of the National University of Shipbuilding, Doctor of Technical Sciences, Full Professor.

Methodological examination was carried out by:

Kalashnikova, Svitlana Andriyivna, Director of the Institute of Higher Education of the National Academy of Pedagogical Sciences of Ukraine, Doctor of Pedagogical Sciences, Full Professor.

Shtykova, Svitlana Petrovna, Director of National Erasmus+ Office in Ukraine (EU Project)

The Standard has been considered by the Ministry of Economic Development and Trade of Ukraine and the Federation of Employers of Ukraine.

The Standard was considered after receiving all comments and suggestions and approved at a meeting of the working group of the Subcommittee 122 Computer Science of the Scientific and Methodological Committee 8 on Information Technology, Automation and Telecommunications, 13.12.2018, Record #3/2018.

The Standard was approved by a  decision of the National Agency for Quality Assurance in Higher Education of June 26, 2019, Record #6.

II. General Description



Higher education level	First (bachelor's) level
Higher education degree	Bachelor
Field of knowledge	12 "Information Technologies"
Specialty	122 "Computer Sciences"
Form of study restrictions	none
Educational qualification	Bachelor of computer sciences in the specialty (specify the specialty if present)
Qualification in diploma	Higher education degree – Bachelor Specialty – 122 Computer Sciences Major – (specify the name of major if present) Educational program – (specify the name of educational program)



Subject field description	<p><i>Object(s) of study and/or activity:</i></p> <ul style="list-style-type: none">- mathematical, informational, simulation models of real phenomena, objects, systems and processes, subject areas, presentation of data and knowledge- methods and technologies for obtaining, storing, processing, transmitting and using information, data mining and decision making- theory, analysis, development, evaluation of efficiency, implementation of algorithms, high-performance computing including parallel computing and big data. <p><i>Learning objectives:</i> training specialists capable of conducting theoretical and experimental research in the field of computer science; applying mathematical methods and algorithmic principles in modeling, design, development and maintenance of information technology; conducting the development, implementation and maintenance of intelligent systems for processing and analysis of data of organizational, technical, naturalist and socio-economic systems.</p> <p><i>Theoretical content of the subject area:</i> modern models, methods, algorithms, technologies, processes and methods of obtaining, presenting, processing, analyzing, transmitting, storing data in information systems.</p> <p><i>Methods, techniques and technologies:</i> mathematical models, methods and algorithms for solving theoretical and applied problems that arise in the development of IT; modern technologies and platforms of programming; methods of collecting, analyzing and</p>
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	consolidating distributed information; technologies and methods of the design, development and quality assurance of IT components; computer graphics methods and data visualization technologies; knowledge engineering technologies, CASE-technologies of IT modeling and design; <i>Tools and equipment:</i> distributed computing systems; computer networks; mobile and cloud technologies, database management systems, operating systems.
Academic and professional rights of the graduates	They have the right to continue their studies at the second (master's) level of higher education. Acquisition of additional qualifications in the system of postgraduate education.

III. The Volume of ECTS Credits Necessary for Obtaining the Higher Education Degree of Bachelor

The volume of the bachelor's degree educational program in the specialty 122 "Computer Sciences" is:

- on the basis of complete general secondary education - 240 ECTS credits;

To obtain a bachelor's degree on the basis of a junior bachelor's degree (the educational qualification level of "junior specialist"), a higher education institution has the right to recognize and reassign no more than 120 ECTS credits received under the previous junior bachelor (junior specialist) training program in the specialties within the field, and not more than 60 ECTS credits received under the previous junior bachelor (junior specialist) training program in other specialties.

At least 50% of the educational program volume should be aimed at providing general and special (professional) competencies in the specialty defined by the Higher Education Standard.

IV. List of the Competencies of Graduate

Integral competence	Ability to solve complex specialized problems and practical problems in the field of computer sciences or in the process of learning, which involves the application of theories and methods of information technology and is characterized by complexity and uncertainty of conditions.
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General competencies	<p>GC1. Ability to think abstractly, to analyze and synthesize.</p> <p>GC2. Ability to apply knowledge in practical situations.</p> <p>GC3. Knowledge and understanding of the subject area and understanding 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>
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	<p>GC6. Ability to learn and master modern knowledge.</p> <p>GC7. Ability to search, 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 informed decisions.</p> <p>GC12. Ability to evaluate and ensure the quality of work performed.</p> <p>GC13. Ability to act based on ethical considerations.</p> <p>GC14. Ability to exercise one's rights and responsibilities as ones of a member of society, to realize the values of civil (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 increase moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of subject area, its place in the general system of knowledge about nature and society and in the development of society, engineering and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.</p>
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Special (professional, subject) competencies	<p>SC1. 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 the field of computer sciences, analyze and interpret.</p> <p>SC2. Ability to detect statistical patterns of non-deterministic phenomena, use methods of computational intelligence including statistical, neural network and fuzzy data processing, methods of machine learning and genetic programming, etc.</p> <p>SC3. Ability to think logically, build logical conclusions, use formal languages and models of algorithmic calculations, design, develop and analyze algorithms, evaluate their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems.</p> <p>SC4. Ability to use modern methods of mathematical modeling of objects, processes and phenomena, develop models and algorithms for numerical solution</p>
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of mathematical modeling problems, take into account the errors of approximate numerical solution of professional problems.

SC5. Ability to provide a formalized description of operations research tasks in organizational-technical and socio-economic systems for different purposes, determine their optimal solutions, build models of optimal management taking into account changes in the economic situation, optimize management processes in systems for different purposes and hierarchy levels.

SC6. Ability to think systemically, apply systemic analysis methodologies to study complex problems of different nature, methods of formalization and solution of system problems with conflicting goals, uncertainties and risks.

SC7. Ability to apply the theoretical and practical foundations of methodology and modeling technology to study the characteristics and behavior of complex objects and systems, conduct computational experiments with processing and analysis of the results.

SC8. Ability to design and develop software using different programming paradigms: generalized, object-oriented, functional, logical, with appropriate models, methods and algorithms of calculations, data structures and control mechanisms.

SC9. Ability to implement a multi-tier computing model based on client-server architecture including databases, knowledge bases and data warehouses, perform distributed processing of large data sets using clusters of standard servers to meet the computing needs of users including through cloud services.

SC10. Ability to apply methodologies, technologies and tools to manage the life cycle processes of information and software systems, information technology products and services in accordance with customer requirements.

SC11. Ability to conduct data mining based on computational intelligence methods including large and poorly structured data, their prompt processing and the visualization of analysis results in the process of solving applied problems.


SC12. Ability to ensure organization of computational processes in information systems for various purposes, taking into account the architecture, configuration, performance indicators



	<p>of operating systems and system software.</p> <p>SC13. Ability to develop network software that functions based on different topologies of structured cabling systems, uses computer systems and data networks and analyzes the quality of work of computer networks. SC14. Ability to apply methods and means of ensuring information security, develop and operate special software for the protection of information resources of critical information infrastructure objects.</p> <p>SC15. Ability to analyze and functionally model business processes, construct and practically apply functional models of organizational-economic and production-technical systems, methods of risk assessment of their design.</p> <p>SC16. Ability to implement high-performance computing based on cloud services and technologies, parallel and distributed computing in the development and operation of distributed parallel information processing systems.</p>
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V. The Standard Content of Training Higher Education Students Formulated in Terms of Learning Outcomes

- PO1. To apply knowledge of the basic forms and laws of abstract-logical thinking, the basics of methodology of scientific cognition, the forms and methods of extraction, analysis, processing and synthesis of information in the subject area of computer sciences.
- PO2. To use the modern mathematical apparatus of continuous and discrete analysis, linear algebra, analytical geometry, in the professional activities for solving problems of theoretical and applied nature in the process of designing and implementing informatization objects.
- PO3. To use knowledge of the laws of random phenomena, their properties and operations on them, models of random processes and modern software environments to solve problems of statistical data processing and construction of predictive models.
- PO4. To use methods of computational intelligence, machine learning, neural network and fuzzy data processing, genetic and evolutionary programming to solve problems of the recognition, prediction, classification, identification of control objects, etc.

PO5. To design, develop and analyze algorithms  for solving computational and logical problems, evaluate the efficiency and complexity



of algorithms based on the use of formal models of algorithms and computational functions.

- PO6. To use methods of the numerical differentiation and integration of functions, solution of usual differential and integral equations, features of numerical methods and possibilities of their adaptation to engineering problems, to have skills of program implementation of numerical methods.
- PO7. To understand the principles of modeling organizational-technical systems and operations; to use methods of researching operations, solving one- and multicriteria optimization problems of linear, integer, nonlinear, stochastic programming.
- PO8. To use the methodology of systems analysis of objects, processes and systems for the tasks of analysis, forecasting, management and design of dynamic processes in macroeconomic, technical, technological and financial objects.
- PO9. To develop software models of subject environments, choose a programming paradigm from the standpoint of convenience and quality of application for the implementation of methods and algorithms for solving problems in the field of computer sciences.
- PO10. To use developer tools for developing client-server applications, design conceptual, logical and physical models of databases, develop and optimize queries to them, create distributed databases, data repositories and marts, knowledge bases, including through cloud services, using web programming languages.
- PO11. To have the skills to manage the life cycle of software, products and services of information technology in accordance with the requirements and restrictions of customer, be able to develop project documentation (feasibility study, terms of reference, business plan, agreement, contract).
- PO12. To apply methods and algorithms of computational intelligence and data mining in the tasks of classification, forecasting, cluster analysis, search for associative rules using software tools for supporting multidimensional data analysis based on DataMining, TextMining, WebMining technologies.
- PO13. To know the languages of system programming and methods of developing programs that interact with components of computer systems, know network technologies, computer network architectures, have practical skills in the technology of administration of computer network and their software

- PO14. To know the languages of system programming and methods of developing programs that interact with components of computer systems, know network technologies, computer network architectures, have practical skills in the technology of administration of computer network and their software
- PO15. To apply knowledge of the methodology and CASE-tools for designing complex systems, methods of structural analysis of systems, object-oriented design methodology in the development and study



of functional models of organizational-economic and production-technical systems.

PO16. To understand the concept of information security, principles of secure software design, ensure the security of computer networks in the context of incomplete and uncertain source data.

PO17. To perform parallel and distributed calculations, apply numerical methods and algorithms for parallel structures, parallel programming languages in the development and operation of parallel and distributed software.

VI. Forms of the Final Assessment of Higher Education Students

Forms of the final assessment of higher education students	The final assessment is carried out in the form of defense of qualification work
Requirements for the qualification work	<p>The qualification work should include theoretical, system technical or experimental research of a complex specialized task or practical problem in the field of computer sciences, which is characterized by complexity and uncertainty of conditions and requires the use of theories and methods of information technology.</p> <p>There should be no academic plagiarism, falsification or fabrication in the qualification work.</p> <p>The qualification work should be published on the official website of higher education institution or its structural unit, or in the repository of higher education institution.</p>

VII. Requirements for Having an Internal System of Assurance of Quality of Higher Education

At higher education institutions, there should be a system for ensuring by the higher education institution the quality of educational activity and the quality of higher education (internal quality assurance system), which provides for carrying out the following procedures and measures:

- 1) defining the principles and procedures for quality assurance in higher education;
- 2) monitoring and periodic reviewing educational programs;
- 3) annual assessment of higher education students, scientific-pedagogical and pedagogical staff of the higher education institution and regular publication of the results of such assessments on the official website of the higher education institution, on information boards and in any other way;
- 4) ensuring advanced training for pedagogical, scientific and scientific-pedagogical



staff;

5) ensuring the availability of the necessary resources for organizing the educational process, including the independent work of students, for each educational program;

6) ensuring the availability of information systems for effective management of the educational process;

7) ensuring the publicity of information on educational programs, degrees of higher education and qualification;

8) development of the practice of academic integrity, in particular the provision of an effective system for the prevention and detection of academic plagiarism in the scientific works of employees of higher educational institutions and higher education students;

9) other procedures and measures.

A higher education institution's system of educational activity quality assurance and higher education quality assurance (internal quality assurance system), as requested by the higher education institution, is evaluated by the National Agency for Higher Education Quality Assurance (NAHEQA) or by independent higher education institutions (accredited by the former) of evaluation and quality assurance of higher education in terms of its compliance with the requirements for higher education quality assurance system which are approved by the NAHEQA and international standards and recommendations for quality assurance in higher education.

IX. List of Regulatory Documents on which the Higher education Standard Is Based

1. Law of Ukraine "On Higher Education" of 01.07.2014 #1556-VII [Access mode]: <http://zakon4.rada.gov.ua/laws/show/1556-18>

2. Law of Ukraine "On Education" of 05.09.2017 #2145-VIII [Access mode]: <http://zakon5.rada.gov.ua/laws/show/2145-19>

3. Resolution of the Cabinet of Ministers #266 of April 29, 2015 "On Approval of the List of Fields of Knowledge and Specialties in which Higher Education Students Training Is Conducted" [Access mode]: <http://zakon4.rada.gov.ua/laws/show/266-2015-п>;

4. Resolution of the Cabinet of Ministers #1341 of 23.11.2011 "On Approval of the National Qualification Framework" [Access mode]: <http://zakon4.rada.gov.ua/laws/show/1341-2011-п>;

5. Classification of Economic Activity Types: NC 009:2010. – To replace NC 009:2005; In effect from 2012-01-01. – (National Classifier of Ukraine) [Access mode]: <http://www.ukrstat.gov.ua>;

6. Classifier of Professions: NC 003:2010. – To replace NC 003:2005 ; In effect from 2010-11-01. – (National Classifier of Ukraine) [Access mode]: <http://www.dk003.com/>


Other Sources

1 Стандарти і рекомендації щодо забезпечення якості в Європейському просторі вищої освіти. К.: Ленвіт, 2006. – 35 с. ISBN 966-7043-96-7 [Access mode]: http://ihed.org.ua/images/doc/04_2016_ESG_2015.pdf;

2 International Standard Classification of Education (ISCED 2011): UNESCO Institute for Statistics [Access mode]:



<http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf> ;

- 3 ISCED Fields of Education and  Training 2013 (ISCED-F 2013): UNESCO Institute for Statistics [Access mode]:
<http://uis.unesco.org/sites/default/files/documents/isced-fields-of-education-and-training-2013-en.pdf> ;
- 4 Instructional Guidelines on Developing Higher Education Standards Approved by the Order of the Ministry of Education and Science of Ukraine of 01.06.2017 #600 (as Amended by the Order of the Ministry of Education and Science of Ukraine of 21.12.2017 #1648);
- 5 Developing Educational Programs. Instructional Guidelines [Access mode]:
http://ihed.org.ua/images/biblioteka/rozroblennya_osv_program_2014_tempus-office.pdf
- 6 National Educational Glossary: Higher Education [Access mode]:
http://ihed.org.ua/images/doc/04_2016_glossariy_Visha_osvita_2014_tempus-office.pdf;
- 7 Development of the Quality Assurance System of Higher Education in Ukraine: Information-Analytical Review. [Access mode]:
- 8 http://ihed.org.ua/images/biblioteka/Rozvitok_sisitemi_zabesp_yakosti_VO_UA_2015.pdf
- 9 European Credit Transfer and Accumulation System. User's Guide [Access mode]:
http://ihed.org.ua/images/doc/04_2016_ECTS_Users_Guide-2015_Ukrainian.pdf
- 10 EQF-LLL-European Qualifications Framework for Lifelong Learning [Access mode]: https://ec.europa.eu/ploteus/sites/eac-eqf/files/brochexp_en.pdf;
- 11 QF-EHEA - Qualification Framework of the European Higher Education Area [Access mode]:
http://ecahe.eu/w/images/7/76/A_Framework_for_Qualifications_for_the_European_Higher_Education_Area.pdf
- 12 Computer Science 2013: Curriculum Guidelines for Undergraduate Programs in Computer Science. [Access mode]: <http://www.acm.org/education/CS2013-final-report.pdf>
- 13 Tuning Educational Structures in Europe. . [Access mode]:
<http://www.unideusto.org/tuningeu/>

General Director of the Directorate of
 Higher Education and Adult Education

O. I. Sharov



Annex A

Table 1 – Matrix of Conformity of the Competencies Defined by the Standard to the NQF Descriptors

Competence classification according to the NQF		Knowledge	Skill	Communication	Autonomy and responsibility
General competencies					
GC1. Ability to think abstractly, to analyze and synthesize.	Knowledge of the basic forms and laws of abstract logical thinking, the basics of logic, the norms of the critical approach, the basics of methodology of scientific knowledge, the forms and methods of analysis and synthesis	To acquire systematic knowledge in the field of computer sciences, analyze problems from the point of view of modern scientific paradigms, to comprehend and draw reasonable conclusions from scientific and educational literature and the results of experiments	Implementing social communications in the process of communication with specialists and non-specialists in the field of computer sciences, ensuring the exchange of logical arguments in order to achieve mutual understanding and agreement	Responsibility for the task assigned, independence in decision-making concerning solving problems in the field of computer sciences	
GC2. Ability to apply knowledge in practical situations	Knowledge of methods of teaching, organization and implementation, stimulation and motivation of educational and cognitive activities, understanding the subject area of computer sciences	To implement the mastered notions, concepts, theories and methods in intellectual and practical activities in the field of computer science, comprehend the content and sequence of application of methods of action, summarize and systematize the results of work	Capacity for sociability, emotional stability, endurance, tact, defending one's point of view, clear expression of one's opinion	Organization of one's work for achieving the result, performance of mental and practical actions, procedures and operations, awareness of the responsibility for the results of one's activity, application of self-control and self-estimation	
GC3. Knowledge and understanding of the subject area and professional activity	Knowledge of the lexical, grammatical, stylistic features of state and foreign vocabulary, the terminology in the field of computer sciences, grammatical structures for understanding and producing orally and in writing foreign texts in the professional field	To communicate in the state language and foreign ones at a professional level, develop in the state language and foreign ones documentation for information technology systems, products and services, read, understand and apply technical documentation in Ukrainian and	Possession and use of lexical and syntactic models typical for professional communication, construction of oral and written communications in the state language and foreign ones based on the goals and situation of communication	Responsibility for the accuracy and correctness of statements in the state language and foreign ones	
GC4. Ability to communicate in the state language both orally and in writing					
GC5. Ability to communicate in a foreign language					



<p>GC6. Ability to learn and master modern knowledge.</p>	<p>Knowledge of methods and techniques of learning, methods of self-education, the basics of scientific and research activities, methods of search, collection, analysis and processing of information.</p>	<p>foreign languages in one's professional activities</p> <p>To evaluate the subject of educational activity, determine the general purpose and specific tasks, choose adequate means to solve them to achieve the results, exercise the necessary self-control, use reference books and technical documentation, develop and apply in the professional activities one's creative abilities, organize the workplace, plan one's work time</p>	<p>Use of communicative competence for effective interaction in different areas of communication; selection and systematization of information materials for the purpose of communication in the professional field, use of mass media for receiving, processing and creation of actual information in the form of documents, abstracts, reports, articles, interviews; improving one's personal communication competence based on skills and abilities of interpersonal communication</p>	<p>To be responsible for one's professional responsibilities and work performed, show independence in making independent generalizations; making independent decisions and performing independent actions in the process of overcoming learning difficulties based on one's own experience of creative problem solving.</p>
<p>GC7. Ability to search, process and analyze information from various sources</p>	<p>Knowledge of methods, ways and technologies of collecting information from various sources, content analysis of documents, analysis and data processing</p>	<p>To use search engine technologies and tools, methods of data and text mining, process, interpret and summarize data</p>	<p>Using a system of documentary and information communications to meet the information needs in the field of computer sciences</p>	<p>Independence in data processing, interpretation and generalization, responsibility for the efficiency, accuracy and reliability of data submission</p>
<p>GC8. Ability to generate new ideas (creativity)</p>	<p>Knowledge of the main stages and phases of creative process, the role of correct formulation of goals and objectives for their achievement in computer sciences, human creative possibilities, the mechanism of genesis and development of knowledge, methods of generating ideas,</p>	<p>To show curiosity, risk-taking, ability to think, to be inspired by new ideas, to implement them, to captivate others with them, to combine and experiment</p>	<p>Realization of professional and communicative contacts, understanding of interlocutors, psychological influence in the process of communication, adequate understanding of verbal and nonverbal communicative signals, ability to overcome communicative barriers</p>	<p>Independence and responsibility for generating new ideas and decision-making in the field of computer sciences in the process of developing methods, models, algorithms and their implementation</p>



	creativity as a universal process of generating unusual ideas	To build connections and relationships with people, take into account the opinion of colleagues, understand other people, express trust in the team, admit one's mistakes, avoid and prevent conflicts, restrain one's personal ambitions. To carry out the selection and preparation of information and tasks for the project team, set goals, formulate tasks for the implementation of projects and programs	Planning communications in one's team and with customers, compliance with correct behavior, sticking to tolerance, order, recognition of other people's opinions and correct discussion, overcoming one's selfish views, principles of self-criticism, dissemination of information about the progress of work	Free expression of one's opinions while working in a team, responsibility for the results of one's team, responsibility of the leader to his/her team
GC9. Ability to work in a team GC10. Ability to be critical and self-critical	Knowledge of the principles of teamwork, team values, the basics of conflictology. Knowledge of IT project management methodology, PMBOK standards, software tools for IT project management	To analyze the strengths and weaknesses of a decision, weigh and analyze the opportunities and risks of decisions taken, evaluate the effectiveness of decisions taken	Conducting business negotiations to transfer information using situation analysis, argumentation and counterargumentation	To be responsible for the decisions made, including in non-standard situations, to defend one's decisions
GC11. Ability to make informed decisions	Professional knowledge in the field of computer sciences, knowledge of methodological approaches to the procedures of preparation and decision-making of organizational and managerial nature, of the order of behavior in non-standard situations	To apply in one's work international standards for the assessment of quality of software, management and maintenance of IT services, models for assessing the maturity of software development processes	Development of communication plans in a project; to prepare and conduct meetings; problem detection and diagnosis of conflicts during the conduct of work.	To be responsible for the quality of work performed, for ensuring the fulfillment of obligations under a contract.
GC12. Ability to evaluate and ensure the quality of work performed	Knowledge of international standards for the assessment of quality of software, management and maintenance of IT services, models for assessing the maturity of software development processes, methods of IT systems quality assurance			



GC13. Ability to act based on ethical considerations	Knowledge of the system of general norms of moral behavior of a person and a group of people, ethical principles,	To implement a system of moral relations in one's professional activities	Ability to plan and implement interpersonal communications based on	Responsibility to one's colleagues and society for the result of work, ability to maintain
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	understanding of the code of professional morality		the moral principles determined by the humanity	the reputation of one's social group, compliance with the moral ideal of a professional
GC14. Ability to exercise one's rights and responsibilities as ones of a member of society, to realize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.	Knowledge of the concept of development of civic education in Ukraine, national and universal values, the basics of legal education of citizens	To implement one's own constitutional rights and responsibilities, use opportunities to influence decision-making processes at the national and local levels.	Social communications and collaboration to address issues of communities of various levels, including through volunteering.	Responsible attitude to one's civil rights and responsibilities related to the participation in socio-political life.
GC15. Ability to preserve and increase moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of subject area, its place in the general system of knowledge about nature and society and in the development of society, engineering and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.	Knowledge of the history and patterns of development of subject area and its place in the general system of knowledge about nature and society and in the development of society.	To use different types and forms of physical activity for active recreation and a healthy lifestyle	Involvement of participants in the educational process in activities, joint management and practical solutions to issues in teams.	To be responsible for the preservation and promotion of moral, cultural, scientific values and the achievements of society.
Special (professional) competencies				
SC1. 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 the field of computer sciences, analyze and interpret	Knowledge of the theoretical and applied provisions of continuous and discrete analysis including infinitesimal analysis, integral calculus, linear algebra, analytical geometry, differential equations, functional analysis,	To effectively use the modern mathematical apparatus in one's professional activities to solve problems of theoretical and applied nature in the process of analysis, synthesis and design of information systems by industry	Ability to effectively form a communication strategy through the accuracy of argumentation in mathematical statements	Ability to solve professional problems independently, using the modern mathematical apparatus and to be responsible for the obtained solutions



<p>SC2. Ability to detect statistical patterns of non-deterministic phenomena, use methods of computational intelligence including statistical, neural network and fuzzy data processing, methods of machine learning and genetic programming, etc</p>	<p>combinatorics, graph theory, Boolean algebra Knowledge of the laws of random phenomena, their properties and operations on them, probabilistic methods of studying complex systems, basic concepts of mathematical statistics, methods of empirical data processing, methods of computational intelligence, machine learning, neural network and fuzzy data processing, genetic and evolutionary programming</p>	<p>To solve typical problems using the basic theorems of probability theory; build models of random processes and analyze them; apply probabilistic and statistical methods to estimate stochastic processes; use modern environments to solve problems of the statistical processing of experimental data; apply neural network methods and technologies, machine learning methods to solve problems of recognition, prediction, classification, object identification, control, etc.</p>	<p>Ability to substantiate one's own opinion on the application of methods of statistical data processing and evaluation of the real world, methods of computational intelligence, including machine learning and neural network technologies, in communication with colleagues, clients, partners, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to solve professional problems independently using the modern mathematical apparatus of probability theory and mathematical statistics, methods of computational intelligence, including machine learning and neural network technologies, and to be responsible for the obtained solutions</p>
<p>SC3. Ability to think logically, build logical conclusions, use formal languages and models of algorithmic calculations, design, develop and analyze algorithms, evaluate their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems.</p>	<p>Knowledge of the basic concepts of algorithm theory, formal models of algorithms, primitively recursive, generally recursive and partially recursive functions, of the issues of computability, solvability and unsolvability of mass problems, of the concepts of temporal and spatial complexity of algorithms in solving computational problems.</p>	<p>To use formal models of algorithms and computational functions, establish the solvability, partial solvability and unsolvability of algorithmic problems, design, develop and analyze algorithms, evaluate their efficiency and complexity.</p>	<p>Ability to communicate with colleagues, clients, partners on specific issues of the design and modeling of information and software systems, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to substantiate one's own opinion on the design, development and analysis of algorithms and computational functions in the modeling of subject areas.</p>



<p>SC4. Ability to use modern methods of mathematical modeling of objects, processes and phenomena, develop models and algorithms for numerical solution of mathematical modeling problems, take into account the errors of approximate numerical solution of professional problems.</p>	<p>Knowledge of numerical methods of linear and nonlinear algebra, approximation of functions, methods of numerical differentiation and integration of functions, solution of ordinary differential, integral equations and partial differential equations, methods of graph theory, set-theoretic, logical, linguistic methods and possibilities of their adaptation to engineering problems.</p>	<p>To use mathematical packages and develop programs for the implementation of numerical methods in solving engineering problems; evaluate the effectiveness of numerical methods, in particular the convergence, stability and complexity of implementation; apply methods based on set-theoretic representations, mathematical logic, graphs and other sections of mathematics for analysis, research of managerial tasks and modeling of research objects.</p>	<p>Ability to substantiate one's own views on the problem to be solved, communicate with colleagues, clients, partners on specific issues of the design and modeling of information and software systems and technologies, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences etc.</p>	<p>Ability to independently determine the formulation of a problem, to choose a numerical method for its solution, to guarantee a given accuracy of the carried out calculations, to be responsible for the obtained solutions.</p>
<p>SC5. Ability to provide a formalized description of operations research tasks in organizational-technical and socio-economic systems for different purposes, determine their optimal solutions, build models of optimal management taking into account changes in the economic situation, optimize management processes in systems for different purposes and hierarchy levels.</p>	<p>Knowledge of the concepts of operations, operation models, stages of operation model development; classification of economic-mathematical models and methods; principles of modeling of organizational-technical systems and operations; methods for solving problems of linear, integer, nonlinear, stochastic, dynamic programming; features of construction and solution of multicriteria problems.</p>	<p>To formulate the goal of management of organizational-technical and economic systems, form a system of management quality criteria, build a mathematical model of the problem, choose and apply the appropriate method of solving the optimization problem, find its optimal solution, adjust the model and solution based on new knowledge about the problem and operation, use software to find optimal solutions to problems of organizational-economic management</p>	<p>Ability to substantiate one's point of view on the problem to be solved, communicate with colleagues, clients, partners on specific issues of the activity of an enterprise, institution, organization, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to independently solve problems of the professional activity with the use of modern methods, technical and scientific literature, the use of modern software; the performance of certain functions of organizational-technical management related to information processing, construction of models of situation analysis, preparation of decisions on optimization of activity, functioning of the information systems of an organization.</p>



<p>SC6. Ability to think systemically, apply systemic analysis methodologies to study complex problems of different nature, methods of formalization and solution of system problems with conflicting goals, uncertainties and risks.</p>	<p>Knowledge of the system analysis methodology for systematic research of deterministic and stochastic models of objects and processes, design and operation of information systems, products, information technology services, other objects of the professional activity.</p>	<p>To describe the subject area, apply the principles of a systematic approach to modeling and design of systems and objects of informatization, perform systematic analysis of the business processes of management systems, reveal uncertainties and analyze multifactorial risks; find solutions to poorly structured problems.</p>	<p>Ability to substantiate one's own opinion on systematic analysis of complex objects and processes, methods of formalizing system tasks in the design of complex systems, communicate with colleagues, customers, partners on specific issues of information and software systems, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to independently assess and form a research apparatus, independently determine the feasibility and possibility of revealing the existing uncertainty to formalize a problem, be responsible for decisions on the logical organization, properties and behavior of complex systems that are designed.</p>
<p>SC7. Ability to apply the theoretical and practical foundations of methodology and modeling technology to study the characteristics and behavior of complex objects and systems, conduct computational experiments with processing and analysis of the results.</p>	<p>Knowledge of queuing systems, Petri nets; methodology of probabilistic and simulation modeling of objects, processes and systems; planning and conducting experiments with models, decision-making to achieve the goal based on the results of modeling.</p>	<p>To identify the components of structural and parametric identification of models of real systems, apply methods of modeling complex objects and systems using appropriate software, assess the degree of completeness, adequacy, truthfulness and feasibility of models of real systems.</p>	<p>Ability to substantiate one's own opinion on models of systems and the methodologies of modeling of objects and processes, communicate with colleagues, clients, partners on concrete questions of the methodology and technology of modeling of objects and systems, make analytical reports, accounts in writing and to present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to independently determine the statement of a problem, to build an information model, choose a method or environment for modeling, perform the modeling of an object or system, be responsible for decisions to achieve the goal based on the results of modeling.</p>
<p>SC8. Ability to design and develop software using different programming paradigms: generalized, object-oriented, functional, logical, with appropriate models, methods and</p>	<p>Knowledge of data structures and fundamental algorithms, methodology and tools of object-oriented analysis and design, features of different programming paradigms,</p>	<p>To develop software models of subject environments, choose a programming paradigm from the standpoint of convenience and quality of application for the implementation of methods and algorithms for solving problems in the field</p>	<p>Ability to effectively form a communication strategy in the process of team software development and decision making on programming paradigms, methods and algorithms</p>	<p>Ability to independently prepare tasks and develop design solutions taking into account the uncertainty factor, to develop appropriate methodological and regulatory</p>



<p>algorithms of calculations, data structures and control mechanisms.</p>	<p>principles, models, methods and technologies of the design and development of software products for different purposes.</p>	<p>of computer sciences, create reliable and effective software.</p>	<p>of calculations, data structures and control mechanisms.</p>	<p>documents as well as proposals and measures for the implementation of developed projects and programs.</p>
<p>SC9. Ability to implement a multi-tier computing model based on client-server architecture including databases, knowledge bases and data warehouses, perform distributed processing of large data sets using clusters of standard servers to meet the computing needs of users including through cloud services.</p>	<p>Knowledge of principles, tools, languages of web programming, technologies of creating databases, data storages and marts and knowledge bases for developing distributed applications with integration of databases and data storages into client-server architecture.</p>	<p>To use methods, technologies and tools for the design and development of client-server applications, design conceptual, logical and physical models of databases, develop and optimize queries to them, create distributed databases, data repositories and marts, knowledge bases, including through cloud services.</p>	<p>Ability to substantiate one's own opinion on the architecture and technologies of client-server application development including databases and data repositories, queries to them, form a communication strategy with colleagues, clients, partners on specific issues of client-server application development, draw up analytical reports, accounts in writing and present the results of one's own work at meetings, conferences, etc.</p>	<p>Ability to implement, in a team, a multilevel client-server application, independently integrate databases and data warehouses in the process of developing distributed software, be responsible for decisions about the logical organization, properties and performance of client-server software.</p>
<p>SC10. Ability to apply methodologies, technologies and tools to manage the life cycle processes of information and software systems, information technology products and services in accordance with customer requirements.</p>	<p>Knowledge of standards, methods, technologies and tools for managing the life cycle of information and software systems, products and services of information technology.</p>	<p>To use methodologies, technologies and tools to manage the life cycle of information systems, software, products and services of information technology in accordance with the requirements and restrictions of customer; the ability to prepare project documentation (feasibility study, terms of reference, business plan, creative brief, agreement, contract, etc.).</p>	<p>Ability to carry out and develop communications with Ukrainian and foreign partners, current interaction and joint elaboration of decisions made and initiatives for the development of cooperation: conducting business negotiations on the development of information and software systems.</p>	<p>Ability to implement, in a team, life cycle models in modern methodologies for the development of information and software systems, independently make decisions to improve project efficiency and change the business processes of organization.</p>



<p>SC11. Ability to conduct data mining based on computational intelligence methods including large and poorly structured data, their prompt processing and the visualization of analysis results in the process of solving applied problems.</p>	<p>Knowledge of methods and algorithms of analytical processing and intellectual analysis of large data sets for classification, forecasting, cluster analysis, search for associative rules using software tools to support data analysis and decision making.</p>	<p>To use DataMining, TextMining, WebMining technologies for data mining, crowdsourcing, integration of heterogeneous data from different sources for in-depth analysis, machine learning, forecasting based on basic models, artificial neural networks, for image recognition, etc.</p>	<p>Creative interaction with colleagues and partners in the process of intellectual analysis of big data and their operational analytical processing. Ability to convince partners of the need to use certain methods and technologies of multidimensional analysis of big data in solving the problems of strategic development of companies.</p>	<p>Independent selection and decision-making on methods and algorithms for analytical processing and intellectual analysis of big data for applied problems in the field of computer sciences.</p>
<p>SC12. Ability to ensure organization of computational processes in information systems for various purposes, taking into account the architecture, configuration, performance indicators of operating systems and system software.</p>	<p>Knowledge of computer architecture, operating system (OS) functions, software interfaces for applications to access OS facilities, system programming languages and software development methods that interact with computer system components.</p>	<p>To solve the issues of administration, effective use, security, diagnosis, recovery, monitoring and optimization of the work of computers, operating systems and system resources of computer systems.</p>	<p>Ability to effectively form communication strategies in the field of organization of computational processes in information systems for various purposes.</p>	<p>To independently plan and schedule tasks, manage memory, files, processes, I/O devices; handle interrupts using various operating systems and system software.</p>
<p>SC13. Ability to develop network software that functions based on different topologies of structured cabling systems, uses computer systems and data networks and analyzes the quality of work of computer networks.</p>	<p>Knowledge of network technologies, computer network architecture, technology of administrating computer networks and their software in the process of performing distributed computing.</p>	<p>To know the methods and tools of working with computer networks; choose the configuration, type and structure of a computer network; operate computer networks in the process of performing distributed computing.</p>	<p>Ability to implement communication strategies using computer networks and distributed software.</p>	<p>To independently and responsibly choose the configuration, type and structure of a computer network; to operate computer networks in the process of performing distributed computing.</p>
<p>SC14. Ability to apply methods and means of ensuring information security, develop and operate</p>	<p>Knowledge of the concept of information security, the principles of secure IC and IT design.</p>	<p>To maintain the confidentiality, integrity and availability of information, ensure the authenticity,</p>	<p>Ability to effectively form communication strategies in the process of forming the concept</p>	<p>To independently manage messages and documents, to be responsible for the content</p>



<p>special software for the protection of information resources of critical infrastructure objects.</p>	<p>secure programming methodologies, threats and attacks, computer network security, cryptographic methods.</p>	<p>traceability and reliability of information in conditions of incompleteness and uncertainty of the original data, the multicriteriality of professional tasks.</p>	<p>of information exchange, coding and selection of communication channel, transmission of messages and documents through the channel, storage and retrieval of documents, implementation of feedback.</p>	<p>of information resources that require information protection.</p>
<p>SC15. Ability to analyze and functionally model business processes, construct and practically apply functional models of organizational-economic and production-technical systems, methods of risk assessment of their design.</p>	<p>Knowledge of the methodology and technology of designing complex systems, CASE-tools for their design, methods of structural analysis of systems, object-oriented project design and documentation methodology, methods of assessing the complexity of developing complex systems.</p>	<p>To use technologies for designing complex systems, choose CASE tools; formulate technical and economic requirements, develop information and software systems using templates and computer-aided design tools.</p>	<p>Ability to effectively form communication strategies in the field of organizing teamwork in the process of design and development of information and software systems.</p>	<p>Independent choice of and decision-making on methods of analysis and functional modeling of business processes, construction and practical application of functional models of organizational-economic and production-technical systems.</p>
<p>SC16. Ability to implement high-performance computing based on cloud services and technologies, parallel and distributed computing in the development and operation of distributed parallel information processing systems.</p>	<p>Knowledge of the architecture and software of high-performance parallel and distributed computing systems, numerical methods and algorithms for parallel structures.</p>	<p>To perform parallel and distributed calculations, apply numerical methods and algorithms for parallel structures, parallel programming languages in the development and operation of parallel and distributed software.</p>	<p>Ability to effectively form communication strategies when performing parallel and distributed computing.</p>	<p>Independent choice of, decision-making on and responsibility for numerical methods and algorithms for parallel structures, languages of parallel programming in the development and operation of parallel and distributed software.</p>

