

**MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE
REPUBLIC OF KAZAKHSTAN**



GRADUATE PROFILE (DOCTOR'S DEGREE)

**Of Educational Program
8D06101 – Software Engineering
(M094 «Information Technologies»)**

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INTRODUCTION

The educational program 8D06101 «Software Engineering» is developed within the framework of the 8D06 «Information and Communication Technologies» field and aims to prepare highly qualified specialists capable of addressing complex challenges in software development and systems integration. In the context of rapidly advancing technologies and increasing demands for software solutions, graduates of this program will leverage their expertise to implement innovative approaches across various industries, including business, healthcare, finance, and others.

The program provides in-depth study of disciplines such as Foundations of Software Engineering, Big Data Storage Systems and Computations, High Load Distributed Computing, along with courses on research methodologies and academic writing. These subjects ensure a comprehensive learning approach, combining theoretical knowledge with practical skills for efficient software solution development, big data processing, and the application of advanced technologies in process automation.

A key aspect of the program is the preparation of graduates with both technical and analytical competencies, including critical thinking and research capabilities, which are essential in the fast-evolving technological landscape. Special emphasis is placed on courses like Doctoral Research Work and Research Practice, designed to develop independent research skills and prepare students for the successful defense of their doctoral dissertation.

The educational process is organized under a credit-based learning system, allowing for a flexible and personalized educational trajectory for each doctoral student. The curriculum includes internships, participation in research projects, dissertation defense, and culminates in a final certification that comprehensively evaluates the professional readiness of graduates.

Thus, the 8D06101 «Software Engineering» program is designed to develop competitive specialists capable of designing and implementing cutting-edge solutions for software development and systems integration, effectively contributing to the modern IT sector and advancing scientific research.

1 Goals and Objectives of the Educational Program 8D06102 – «Software Engineering»

Goal:

The educational program aims to prepare researchers capable of independently conducting scientific research, developing complex software solutions, working effectively in teams, and navigating modern information technologies. The program focuses on training highly qualified specialists equipped to independently carry out research, design comprehensive software solutions, collaborate within multidisciplinary teams, and confidently address contemporary challenges in software engineering. The objective is to develop competencies essential for practice-oriented innovation in software development, original scientific research, and the implementation of innovative solutions across various industries.

Objectives:

- Provide doctoral students with practical skills and knowledge necessary for work in software development and systems engineering.
- Develop the ability to apply theoretical knowledge to practical challenges in software engineering.
- Create conditions for conducting original scientific research in software development.
- Facilitate the publication of research results in international and national peer-reviewed journals.
- Train doctoral students in methods of conducting research and performing scientific analysis in the field of software engineering.
- Develop skills for designing and implementing efficient software systems to solve practical problems.
- Educate doctoral students on creating and optimizing software for diverse applications and industries.
- Prepare doctoral students to design and implement complex software systems and infrastructures.
- Teach the use of modern tools and technologies applied in software development.
- Foster the ability to work in interdisciplinary teams and effectively interact with professionals from other fields.
- Train students in communication skills and the ability to present their work effectively.
- Promote lifelong learning and continuous professional development for doctoral students.
- Cultivate critical thinking skills and the ability to learn independently.

– Instill a sense of responsibility and ethical considerations in software development.

– Ensure understanding of the social, economic, and environmental implications of software development and its usage.

This comprehensive approach is designed to prepare doctoral students not only as specialists in their field but also as innovative thinkers and ethical contributors to the evolving technological landscape.

2 List of Qualifications and Positions

Graduates of the 8D06101 – «Software Engineering» program are awarded the degree of Doctor of Philosophy (PhD) in Technical Sciences upon successful defense of their doctoral dissertation. The educational program is developed in accordance with the State Mandatory Standards for Higher and Postgraduate Education, approved by the Order of the Minister of Science and Higher Education of the Republic of Kazakhstan dated July 20, 2022, No. 2 (registered in the State Register of Regulatory Legal Acts under No. 28916). It is aimed at achieving learning outcomes that determine the content of curricula, including working and individual educational plans, as well as course syllabi.

Graduates of the 8D06102 – «Software Engineering» program are qualified to hold the following positions:

- Lead Machine Learning Engineer;
- Senior Data Analysis Specialist;
- Team Leader for Artificial Intelligence Algorithm and Model Development;
- Big Data Architect;
- Lead Cloud Computing Engineer;
- Project Manager in IT and Data Science;
- Research Scientist in Machine Learning and Data Analysis;
- Professor or Associate Professor at a higher education institution.

Professional Field:

The professional field of the graduate encompasses all sectors of the economy where machine learning methods and data analysis technologies are actively applied, including healthcare, finance, retail, information technology, and scientific research.

Objects of Professional Activity:

– The objects of professional activity for a Doctor of Philosophy (PhD) in this field include:

- Innovative machine learning models and data analysis algorithms developed for complex applied and scientific tasks;
- Systems for big data processing and storage, including distributed and cloud platforms;
- Specialized platforms and technologies for high-load computing and their integration with artificial intelligence systems;
- Tools and methodologies for advanced data analytics and interpretation across various interdisciplinary domains.

3 Descriptors

The requirements for the qualification level of a doctoral candidate in the 8D06101 – "Software Engineering" program are based on the Dublin Descriptors for the third cycle of higher education (doctoral studies) and define the set of competencies expressed through learning outcomes. The descriptors describe the key capabilities of the graduate:

- Possess deep and specialized knowledge in machine learning and data science, including the latest theories, methodologies, and technologies. The doctoral candidate must be able to apply this knowledge to conduct original scientific research, create innovative solutions, and develop software systems capable of addressing modern challenges by integrating the latest advancements in science and technology.

- Perform comprehensive analysis and interpretation of large datasets using modern methods of machine learning, statistics, and artificial intelligence. The doctoral candidate should have the skills to adapt algorithms and tools to diverse tasks and requirements, ensuring high accuracy, reliability, and scalability of results.

- Design and improve complex models and machine learning algorithms to address both research and practical challenges. The graduate must be capable of developing new methodologies, algorithms, and tools while optimizing existing approaches to enhance the performance and efficiency of data processing.

- Critically evaluate and interpret the outcomes of research and developments, considering their scientific, social, and ethical aspects. This includes understanding the ecological and societal impacts of research, adhering to standards for responsible research, and recognizing ethical considerations in the creation and use of technologies.

- Demonstrate the ability to transfer knowledge and present complex ideas in an accessible form to both the scientific community and the broader audience. The graduate should effectively present the results of their research, publish scientific papers in peer-reviewed journals, and participate in conferences, sharing knowledge and discoveries.

- Exhibit a high degree of independence in research activities, showing readiness for continuous self-learning and adaptation to rapidly changing technological demands. The graduate should demonstrate the ability to expand their knowledge and skills in data science and machine learning, employing innovative approaches and resources for ongoing professional growth.

These descriptors ensure that graduates are not only equipped with advanced technical and analytical skills but also capable of contributing to the development of science, industry, and society through responsible and impactful research and innovation.

4 Competencies Upon Completion of Training

4.1 Requirements for Key Competencies of Graduates of the Scientific and Pedagogical Master's Program

Graduates of the scientific and pedagogical master's program in 8D06101 – «Software Engineering» must possess a comprehensive set of knowledge, skills, and abilities enabling them not only to apply advanced technologies but also to contribute to their development, effectively teach, and transfer knowledge to the next generation of specialists. The competencies formed during the training cover the following key areas:

Understanding of:

- The role of software engineering in advancing modern technologies and its importance in addressing current challenges across various industries, including healthcare, finance, information technology, and education.
- Modern approaches to software development, including Agile, DevOps, and other methodologies, as well as principles of software system design and architecture.
- Contemporary philosophical and methodological aspects of research in software engineering, emphasizing the significance of interdisciplinary approaches for a deeper understanding and comprehensive solutions to current problems.
- Emerging challenges and opportunities in software development, including issues of security, quality, and sustainability.

Knowledge of:

- Fundamental methods and principles of organizing scientific activities, along with key approaches to conducting research in software engineering and software development.
- The methodology of scientific inquiry and the structure of scientific research, incorporating aspects of sustainable development and innovative technologies in software engineering.
- Psychological aspects of cognitive activity required to enhance the effectiveness of teaching and create motivational learning environments.
- Modern programming languages, tools, and technologies for software development, testing, debugging, and code documentation.

Ability to:

- Apply acquired knowledge for conducting independent scientific research and implementing innovative solutions in the field of software engineering.
- Critically assess and apply existing concepts, methods, and approaches to software development, adapting them to research tasks.
- Integrate knowledge from various fields to address complex scientific and applied problems related to designing and implementing software systems.

- Utilize interactive methods and innovative approaches, including project-based learning, real-world project development, and critical case studies, in educational practices.

- Develop and improve software solutions by participating in real research projects and addressing applied problems relevant to different industries.

Skills in:

- Independently conducting scientific research and developing software solutions focused on solving applied problems.

- Applying effective teaching methods and interactive approaches to foster knowledge transfer and motivate learning in software engineering.

- Using modern information technologies, methods of multithreaded and distributed programming to execute high-load projects and process large data volumes.

- Mastering public speaking for communicating scientific knowledge and research results to academic and professional audiences, including at international scientific forums.

- Professional communication and intercultural interaction required for collaboration in international research projects and educational initiatives.

These competencies equip graduates with the ability to contribute to the advancement of software engineering while effectively educating future professionals and collaborating on international projects.

Being Competent in:

- Methods of organizing and conducting scientific research aimed at the practical application of software engineering technologies across various industries.

- Modern educational technologies, including project-based learning and interdisciplinary research, applicable to software development tasks.

- Designing and implementing educational programs and scientific projects aimed at introducing software engineering solutions to address significant social and industrial challenges.

- Maintaining the relevance of one's knowledge and skills through continuous professional development and qualification improvement, essential for success in a rapidly evolving industry.

Professional Competencies:

- The ability to independently acquire, systematize, and apply knowledge to address current challenges in software engineering. This includes the development of innovative approaches, their adaptation, and practical application in research and applied activities.

- The ability to formulate research objectives, develop strategies to achieve them, and define the sequence of tasks and methods required to obtain reliable results and scientific conclusions.

- Proficiency in applying statistical methods, probability theory, and algorithms to solve scientific and practical problems, including processing,

analyzing, and interpreting large volumes of data within the context of software development.

- Expertise in the professional selection and use of software tools for data analysis, software development, and solution modeling, enabling effective information processing and the generation of high-quality results.

- The ability to critically evaluate the outcomes of one's professional activities and present them in scientific articles, conferences, and other academic publications, thereby contributing to the advancement of science and the professional community.

- The ability to draft and format scientific and technical documentation, including reports, reviews, and presentations, to demonstrate research outcomes and make them accessible to the academic and professional community.

- Readiness to effectively lead a team, fostering a productive and inclusive work environment, supporting collaboration, and respecting cultural and social differences.

- Proficiency in a foreign language for presenting research results and participating in international projects, facilitating global knowledge exchange.

General Human and Socio-Ethical Competencies:

- Abstract Thinking and Critical Analysis — Ability to think abstractly, analyze, and synthesize, enabling solutions for complex tasks in software engineering.

- Philosophical and Ethical Awareness — Application of philosophical knowledge to develop a worldview and a critical approach to technology creation, promoting conscious and ethical software use.

- Social and Cultural Understanding — Knowledge of social, cultural, and historical factors affecting societal processes, with the ability to analyze their impact on the adoption and use of technologies in society.

- Economic Knowledge — Proficiency in basic economic principles to evaluate project efficiency and predict outcomes, including assessing risks and costs in software development.

- Legal Awareness — Ability to consider legal aspects and intellectual property issues in professional activities, ensuring data protection and respect for all participants' rights.

- Self-Development and Creativity — Skills to develop professional abilities and creative potential, fostering continuous learning and professional growth.

- Physical Culture and Stress Management — Use of physical fitness techniques to maintain health and manage stress during intensive scientific activities.

- First Aid and Safety Methods — Mastery of first-aid skills and emergency response actions, ensuring safety and resilience in the workplace.

Special and Managerial Competencies

- Environmental Analysis and Risk Management — Ability to analyze anthropogenic impacts on humans and the environment, predict and assess potential risks arising during software development and data handling.

- Designing Safe Systems — Proficiency in modeling processes and designing systems that meet safety requirements, managing risks using analytical and predictive methods.

- Risk Management Tools — Mastery of modern software tools for modeling, evaluating, and managing risks, including big data analysis, ensuring reliability and stability in professional activities.

- Efficiency and Compliance with Standards — Capability to evaluate and ensure systems' compliance with legislative and environmental standards, creating sustainable solutions in software development.

- Legal Competence — Knowledge of legal and regulatory requirements and the ability to apply them in system design, including assessing social and environmental risks, fostering ethical and responsible technology use.

4.2 Requirements for the doctoral student's research work

A doctoral student in the Software Engineering program must have the following competencies and skills to effectively conduct research work:

- Integration of fundamental and applied knowledge — the ability to solve professional problems at the intersection of theory and practice, combining theoretical knowledge about software development with their practical application in real projects. This contributes to the creation of solutions that meet modern requirements for the quality and efficiency of software systems.

- Independence in scientific research — the ability to conduct independent research, formulate scientific questions, develop research methods, collect and analyze data, as well as present the results in a format that meets international scientific standards. The doctoral student should be able to justify his work and contribute to the development of new knowledge and technologies.

- Modeling and system development — skills in designing, modeling and developing software systems, which allows for analysis, simulation and optimization. These skills enable doctoral students to develop effective solutions that can be used in various industries, from information technology to automation and intelligent systems.

- Knowledge of modern information technologies — the ability to use modern tools and platforms for software development, testing and deployment, including specialized development environments, version control systems and Agile methodologies. These skills allow doctoral students to adapt to changing conditions and project requirements.

- Ethics in scientific activity — understanding and applying ethical norms and standards in conducting scientific research, including issues of data protection, confidentiality and intellectual property. This creates responsibility and honesty in doctoral students in their scientific practice.

4.3 Requirements for the organization of practices

The educational program for doctoral students includes pedagogical and research practices aimed at the formation and strengthening of professional and scientific competencies:

- Pedagogical practice is aimed at mastering the methods of teaching and managing the educational process. During this practice, doctoral students participate in educational activities at the bachelor's and master's levels, gain experience in interacting with students, develop mentoring and professional communication skills. This experience helps to develop doctoral students' skills in effective teaching and preparing them for future careers in educational institutions.

- Research practice – organized to introduce doctoral students to modern research methods, including data collection, processing and analysis. This practice helps to develop research skills, allowing you to apply theoretical knowledge in practice and deepen competencies in the field of scientific research. Doctoral students learn to work with modern data analysis tools and develop their own research projects.

These practices contribute to the comprehensive development of doctoral students, helping them acquire the necessary pedagogical and research skills, which prepares them for successful professional activity and achieving significant results in the scientific field.

5 Requirements for completing studies and obtaining a diploma

To successfully complete the educational program of the doctoral program in the direction 8D06101 – «Software Engineering» , a doctoral student must gain at least 180 credits, which are distributed as follows:

- 45 credits for theoretical training covering disciplines necessary for the formation of in-depth knowledge in the field of software development and modern technologies.

- 123 credits for teaching and research practices aimed at developing both professional and research competencies.

- 12 credits for the final certification, which includes the defense of a dissertation research and confirms the qualification of a doctoral student in the field of research and development.

Degree awarded

Graduates of the program are awarded the academic degree «Doctor of Philosophy (PhD)» in the direction 8D06101 – «Software Engineering».

Graduate competencies

Having mastered the doctoral program, the graduate must have the following competencies:

General professional competencies:

- The ability to independently acquire, comprehend and apply new knowledge and skills, which contributes to the development of an innovative approach in professional activities.

- Skills in setting research goals, determining their sequence and choosing methods to solve urgent problems.

- The ability to apply knowledge from fundamental and applied disciplines corresponding to the training profile.

- The ability to critically analyze, present and defend the results of their professional activities.

- Skills in drawing up technical documentation, writing reports, reviews, reports and scientific publications.

- Willingness to lead a team, taking into account socio-cultural differences and principles of tolerance.

- Proficiency in professional communication skills in a foreign language.

Professional competencies by type of activity:

Engineering, design and research activities:

- The ability to perform technical developments of high complexity in the field of software engineering.

- The ability to develop and analyze algorithms and architectures of software systems.

- Skills in applying data analysis methods and processing large amounts of information.

- The ability to use modern programming tools and languages for software development and optimization.

- The ability to design and develop systems to solve specialized problems in the field of software engineering.

Production and technological activities:

- Mastery of the skills of independent execution of design and scientific and production work in the field of software engineering.

- The ability to use the methods of using modern software and developing tools.

- The ability to apply data processing methods to solve applied production tasks.

- Skills in testing and validating software systems.

- The ability to manage the lifecycle of software products, including the stages of development, testing and implementation.

Organizational and managerial activities:

- Readiness to organize and manage research and production projects in the field of software engineering.

- The ability to interact with clients and partners using the standards of project and process documentation.

- The ability to evaluate and choose approaches to software development and integration, taking into account risk management.

Scientific and pedagogical activity:

- Skills in conducting seminars, laboratory and practical classes in the field of software engineering.

- Participation in the development of educational materials and documentation.

- The ability to lead the scientific and educational activities of students in the field of software engineering.

Results of the program development

The doctoral program provides graduates with the necessary general cultural and professional competencies, preparing them for successful professional and research activities in the field of software engineering.

CONCLUSION

The doctoral program in the field of 8D06101 – «Software Engineering» is aimed at training highly qualified scientists and specialists capable of solving complex scientific and practical problems in the field of software development. During their studies, doctoral students master key skills necessary for conducting independent research, critical analysis and design of software systems, as well as for implementing innovative solutions in various industries.

Graduates of the program have comprehensive competencies, including a deep understanding of the theoretical foundations of software engineering, practical skills in software development and testing, as well as managerial and pedagogical abilities. These qualities make them sought-after professionals both nationally and internationally.

The program is aimed at developing research potential, innovative thinking and leadership skills, which contributes to the formation of competent and responsible specialists who are ready for independent scientific and professional activities. Thus, graduates of the 8D06101 – «Software Engineering» program become not only experts in their field, but also leaders who are able to make a significant contribution to the development of science, technology and education at the global level.

**Head of the Department of
«Software Engineering»**



Abdoldina F.N.