ALIKHAN BOKEIKHAN UNIVERSITY

6B06123 "IT IN HEALTHCARE"
MODULE EDUCATIONAL PROGRAM

2024

Developed by the Department of "Information and Technical Sciences"

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1. Explanatory note

The modular educational program (MEP) is compiled on the basis of regulatory documents of the Ministry of Education and Science of the Republic of Kazakhstan and internal regulatory documents of Alikhan Bokeikhan University:

- The State mandatory standard of Higher Education, approved by Order No. 2 of the Minister of Science and Higher Education of the Republic of Kazakhstan dated 20.07.2022.

- Rules for the organization of the educational process on credit technology of education, approved by the Order of the Minister of Education and Science of the Republic of Kazakhstan dated **20.04.2011 No. 152;**

- Standard rules of activity of organizations of higher and (or) postgraduate education, approved by the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 30, 2018 No. 595;

- Structure of the modular educational program;

Professional standard:

- "Software Developers", approved by the Deputy Chairman of the Board of the National Chamber of Entrepreneurs of the Republic of Kazakhstan "Atameken" dated 05.12.2022 No. 222.

- Atlas of new professions «Artificial neural network designer»

The MOS is designed as a set of sequential training modules for the entire period of study and is aimed at mastering the competencies necessary for awarding a bachelor's degree in information and communication technologies under the educational program "6B06123 IT in healthcare".

The modules of the OOD block (56 academic credits in total) include disciplines common to all educational programs, during the study of which the graduate must master the following competencies:general education.

The DB block includes disciplines of the university component (VC) – 30 academic credits and elective components (CV) - 82 academic credits. Modules of these disciplines form a set of competencies: basic and professional.

The PD block includes disciplines of the university component (VC) -22 academic credits and elective components (CV) - 42 academic credits. Modules of these disciplines allow you to form a complex of special and professional competencies acquired by a graduate.

The criterion for the completion of the educational process is the student's mastering of at least 240 credits, including at least 232 academic credits of theoretical training and 8 credits of final certification. The MOS consists of 14 modules that ensure the achievement of the set goals.

The partner of the educational program is the Non-profit Joint Stock Company "Semey Medical University".

During the development of the modular educational program, the wishes and recommendations of potential employers were taken into account, aimed at the formation of professional competencies that meet the requirements of the labor market (round table with employers "Employer – Higher education institution – Future specialist" dated 06.02.2024)

Social partners who took part in the discussion of the MOS: «Semey Medical University» and «Clinic №7»

The purpose of the modular educational program "6B06123 IT in healthcare" is to train qualified specialists in the field of design, creation, administration, operation and maintenance of automated information systems used in healthcare.

ON 1 - to develop specialized modules of the studied CAD in medicine for carrying out strength calculations of the designed structures, to create drawings of parts and assembly drawings based on 3D models; to develop an adequate model of a system or process using modern computer tools; to be able to determine the basic electrical circuits of medical electronic devices for diagnostic and therapeutic purposes.

ON 2 - study the regulatory legal acts of the Republic of Kazakhstan in the field of information security; apply the basic standards in the field of information security; choose the main information security tools; analyze the types of attacks and threats to information security; formulate appropriate requirements for information security systems; apply modern DBMS for database processing; develop database structures taking into account the prospects of using the database; analyze and take measures to solve complex emergency situations and incidents that occur during the operation of the DBMS; apply a range of available database management tools and methods to assess the load when executing database queries.

ON 3 - create interactive elements of Web pages; interpret the basic principles of operating system design, determine the purpose, functions and their classification; analyze calculations to evaluate the effectiveness of computer and telecommunications systems and networks.

ON 4 - define the basic concepts related to information systems, as well as the collection, transmission, processing and storage of information; build a model of the information process, solve problems of optimizing the information process.

ON 5 - Demonstrate knowledge about the idea of a modern rule of law to instill skills of financial literacy, entrepreneurship, leadership, receptivity to innovation based on scientific research in compliance with the principles of academic integrity, as well as ensuring safety standards.

ON 6 - Is able to analyze the basic theoretical and practical skills of programming languages and operating systems for software development, is able to apply artificial intelligence and robotics software development methodologies to improve the quality of healthcare, and develop and implement machine learning models and big data analysis for the diagnosis and prediction of diseases.

ON 7 - describe the main theories of management in healthcare; apply effective communications in the healthcare management system.

ON 8 – interpret the results of medical and biological data in the study and diagnosis of medical examinations; be able to calculate health indicators based on situational tasks, test devices; configure, install diagnostic software.

ON 9 - apply mathematical formulas to describe the most important models, demonstrate knowledge and skills of using fundamental physical laws and theories.

ON 10 - to evaluate the possibilities of methods of encoding and compressing biomedical data in accordance with the conditions of the task; to develop algorithms for filtering and compressing information; to design protocols for information exchange in medical systems: to assess the degree of reliability of the data obtained to solve problems of evidence-based medicine; to determine the principles of designing expert systems in the field of medicine, to create programs and algorithms for expert and information-computing systems of medical orientation.

ON 11 - Is able to apply the basic principles of software design and development of software applications for medical diagnosis, treatment and monitoring of patients; is able to develop preliminary versions of user documentation for software and select standards and tools for software development in the healthcare sector.

ON 12 – He is able to develop and analyze algorithms and data structures, assess their complexity, and is able to use programming language tools to implement software development to improve the quality and efficiency of medical services and healthcare management.

ON 13 - apply the basic principles of modern information and communication technologies in the field of medicine; develop and implement modern information technologies in medicine, apply mathematical methods and modern applied software tools for processing experimental and clinical diagnostic data; apply 3D modeling and neural networks in medicine.

ON 14 - classify information systems and distinguish their characteristic features, evaluate the quality and efficiency of the use of information systems, the basics of network administration and network information systems, network administration.

In order to create special conditions for people with special educational needs to receive education, the graduate's competence model is supplemented with professional competencies that ensure the adaptive nature of the main educational program. For this purpose, courses for the

formation of the ability of persons with special educational needs to successfully socialize in society and actively adapt to the labor market, taking into account the characteristics of the disease, are introduced into the catalog of courses of the additional educational program "Minor".

1.Graduate competence model

As a result of mastering the graduate of the modular educational program 6B06123 IT in healthcare should have the following competencies:

Competencies of general education

- use the basic structures and mechanisms of various operating systems, work with modern operating systems;
- apply the basic concepts of system programming, develop programs covering system programming issues;
- to design an information model of the subject area; to install, configure, use and interact with the relational database management system to represent data using various models;
- compose SQL queries;
- aimed at forming the ideological, civil and moral positions of the future specialist, competitive on the basis of knowledge of information and communication technologies, building communication programs in Kazakh, Russian and foreign languages, orientation to a healthy lifestyle, self-improvement and professional success;
- form a system of general competencies that ensure the socio-cultural development of the personality of the future specialist on the basis of the formation of his ideological, civil and moral positions;
- develop the ability to interpersonal social and professional communication in Kazakh, Russian and foreign languages;
- contribute to the development of information literacy through the mastery and use of modern information and communication technologies in all areas of their lives and activities;
- form skills of self-development and education throughout life;
- form a personality capable of mobility in the modern world, critical thinking and physical self-improvement;
- to evaluate the surrounding reality on the basis of worldview positions formed by knowledge of the fundamentals of philosophy, which provide scientific understanding and study of the natural and social world by methods of scientific and philosophical cognition, to reveal the meaning of the content and specific features of the mythological, religious and scientific worldview;
- to show a civic position based on a deep understanding and scientific analysis of the main stages, patterns, peculiarities of the historical development of Kazakhstan, to use methods and techniques of historical description to analyze the causes and consequences of events in the history of Kazakhstan;
- assess situations in various spheres of interpersonal, social and professional communication, taking into account basic knowledge of sociology, political science, cultural studies, psychology, arguing their own assessment of everything happening in the social and industrial spheres, as well as synthesize knowledge of these sciences as a modern product of integrative processes;
- to use scientific methods, methods of research of a specific science, as well as the entire socio-political cluster, to choose a methodology, analyze and summarize the results of the study;
- to develop their own moral and civic position on the basis of social, business, cultural, legal and ethical norms of the Kazakh society;
- to put into practice knowledge in the field of social sciences and humanities, which has worldwide recognition, synthesize new knowledge and present it in the form of humanitarian socially significant products;

- to engage in communication in oral and written forms in Kazakh, Russian and foreign languages, using linguistic and speech means based on grammatical knowledge to solve problems of interpersonal, intercultural and industrial (professional) communication, as well as to analyze information, actions and deeds of communication participants in accordance with the communication situation;
- use various types of information and communication technologies in personal activities: Internet resources, cloud and mobile services for the search, storage, processing, protection and dissemination of information;
- to build a personal educational trajectory throughout life for self-development and career growth, to focus on a healthy lifestyle to ensure full-fledged social and professional activities through methods and means of physical culture;
- to know and understand the basic laws of the history of Kazakhstan, the basics of philosophical, socio-political, economic and legal knowledge, communication in oral and written forms in Kazakh, Russian and foreign languages;
- apply the acquired knowledge for effective socialization and adaptation in changing socio-cultural conditions, possess the skills of quantitative and qualitative analysis of social phenomena, processes and problems.

Basic competencies:
- to use knowledge about the basic provisions of the theory of differential and integral calculus of functions of several variables, the theory of differential equations, the theory of series;
- create algorithms for solving problems;
- use methods of constructing various models of data types, algorithms for information processing; rationally - use the opportunities provided by technology;
- algorithmization, for solving practical problems;
- organize the necessary data structures;
- fix program errors;
- write programs in a good style;
- use methods of constructing various data models, algorithms for information processing;
- rationally use the opportunities provided by the algorithmization technique to solve practical problems;
- formalize, factorize, normalize, decompose and structure input, intermediate, output data;
- build mathematical models of algorithms.

Professional competencies:
- use information computer systems in medicine and healthcare, theoretical foundations of computer science, collection, storage, search, processing, transformation, dissemination of information in healthcare, state standards on electronic medical history, as well as methods and means of protecting personal data in medical information systems, principles of automation of management of healthcare institutions using modern information technologies, algorithms and software tools to support decision-making during the therapeutic and diagnostic process and software and technical means of medical statistics used at various stages of obtaining and analyzing biomedical information.
- work with electronic healthcare with a mobile application, carry out text and graphic processing of medical data using standard operating system tools and generally accepted office applications, as well as applied and special software tools, use statistical and heuristic algorithms, methods of obtaining knowledge from data, expert systems for the diagnosis and management of treatment of diseases;

- to use programming languages and systems in order to automate information processes for collecting information necessary for processing and making management decisions, to work with general-purpose software, to search for information using search rules (query construction) in databases, computer networks of normative reference information;

- apply instrumental software tools and mathematical models in the decision-making process, formulation and formalization of expert decision support tasks, analysis and interpretation of the results obtained.

Special competencies:

- apply the theoretical foundations of obtaining, collecting, entering, storing, searching, processing, converting, distributing and protecting medical information, types and classification of modern medical information systems, the essence and main provisions of the use of modern information technologies and videoconferencing in medicine, medical science and healthcare, the current state of the level and directions of development of computer technology and software funds for use in the field of medicine;

- to define information systems, tasks of medical information and computing systems, the functional purpose of medical information and computing systems, the concept of an automated control system in medicine, its levels, components, structure, functions, basic requirements, as well as development stages.

- to use modern medical information and telemedicine systems for professional activity, to assess the legality, legitimacy and effectiveness of using modern medical information and telemedicine systems for professional activity, to work with software tools for solving medical problems.

- formulate the goals and objectives of the study; plan, organize and conduct statistical observation in accordance with the tasks set; use tabular and graphical methods of presenting statistical observation materials and formulate conclusions arising from the results of statistical observation, and give a generalizing conclusion on them;

- to develop and analyze the structure of the scheme of the software package of the automated hospital information system of the medical and preventive institution and to include information about hospitalized patients, to form consolidated and personalized accounts for mutual settlements with the medical organization of the AU in the hospital;

- to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies, public speech, argumentation, discussion and polemics; to expand and deepen scientific worldview; the ability to independently acquire and use new knowledge;

- use modern computer tools to create an examination system in the clinic of internal medicine, modern software for processing experimental and clinical diagnostic data, with the introduction of new medical technologies and software and hardware complexes for the study of diseases of internal organs, computational diagnostics and methods for predicting the patient's condition.

Table 2. Mastering the disciplines of socio-professional interactionsequence

№	Competences	The list of compulsory, elective disciplines and the sequence of their study		Expected result
		List of disciplines	The sequence of their study (sem.)	
1	Special competencies	Medbiophysics	3 semester	**To know:** Modern methods of studying the structure and functions of biological membranes. Investigation of surface tension forces.Ionizing radiation. Dosimetry.Principles of conversion of biological and non-electrical signals into electrical structures of sensors and electrodes, their main characteristics. The device, the principle of operation of the electrocardiograph. The main approaches to ECG registration. ECG registration and principles of analysis. The device, the principle of operation of the electroencephalograph.The main rhythms of the EEG. EEG registration and principles of analysis. Laser radiation. The device, the principle of operation of spectrophotometers. Application of spectrophotometric research methods to determine the concentration of substances in biological fluids. Polarization of light by biosystems. Special techniques of microscopy of biological objects. **Be able to:** use physical methods of diagnosis and treatment of patients with the help of sophisticated technical equipment, including for the safe use of ionizing radiation sources; prepare appropriate equipment that conducts medical irradiation of patients as prescribed by a doctor. **Own:** the ability to conduct fundamental and applied research in the field of the effect of physical factors on the human body, ensuring the radiation safety of personnel and ensuring the quality of irradiation of patients when using ionizing radiation sources in medicine; all kinds of physical phenomena, processes and structures observed in nature; conducting physical research; using the results of scientific research in innovation; processing and analyze the received data using modern information technologies; to operate modern physical equipment and equipment; to participate in the information and technical organization of scientific seminars and conferences; to understand and apply in practice management methods in the field of environmental management; excursion, educational and circle work to write and issue scientific articles and reports
				To know: the basics of the interaction of various radiations with biological tissues, the physical foundations of various types of imaging in medicine;

		Medical physics and medical imaging		methods of blood circulation research; integral and regional rheography; methods of indirect registration of shock and minute ejection; physical foundations of hemodynamics; nuclear magnetic resonance. Physics of ultrasound. Physical and technical fundamentals of radiology. The device and principles of operation of X-ray equipment (X-ray, CT); Ultrasound devices; MRI devices. Scintigraphy and radionuclide diagnostics devices. Organization of the work of the X-ray department, darkroom. **Be able to:** use physical methods of diagnosis and treatment of patients with the help of sophisticated technical equipment, including for the safe use of ionizing radiation sources; prepare appropriate equipment that conducts medical irradiation of patients as prescribed by a doctor. **Own**: the ability to conduct fundamental and applied research in the field of the effect of physical factors on the human body, ensuring the radiation safety of personnel and ensuring the quality of irradiation of patients when using ionizing radiation sources in medicine; all kinds of physical phenomena, processes and structures observed in nature; conducting physical research; using the results of scientific research in innovation; processing and analyze the data obtained with the help of modern information technologies; to operate modern physical equipment and equipment; to participate in the information and technical organization of scientific seminars and conferences; to understand and put into practice management methods in the field of environmental management; excursion, educational and circle work; to write and issue scientific articles and reports
2	Special competencies	Public health and healthcare	4 semester	**To know:** about the basic terms and concepts; about the theoretical basis of public health and healthcare as a scientific discipline and subject of teaching (tasks, subjects, methods, principles); about the history of the formation and development of the discipline; about the role and place of social and biological factors in the formation of health (public, group, family, individual) and organization about medical aspects of ethics and deontology in the activity of a doctor. **Be able to:** register the data of patients who have applied for medical care to the PHC organization; draw up medical documentation of patients receiving medical care in the PHC organization; pre-registration of patients for an appointment with doctors; registration of receiving calls from doctors at home; receive unreasonable calls from the ambulance service during the hours of the PHC organization and transfer unreasonable calls for emergency medical care

				science; inform the population about the order of work of the polyclinic, about the time and place of reception of the population by the chief physician, his deputies, doctors and all specialties, about the volume of diagnostic studies in the polyclinic. **To own:** to form a register of the attached population, including in electronic format; to carry out the selection and delivery of medical documentation to doctors' offices; to ensure proper management and storage of the card file to regulate the intensity of the population flow in order to create a uniform load of doctors.
		Social medicine		**To know:** about the basic terms and concepts; about the theoretical basis of public health and healthcare as a scientific discipline and subject of teaching (tasks, subjects, methods, principles); about the history of the formation and development of the discipline; about the role and place of social and biological factors in the formation of health (public, group, family, individual) and health organization; about medical aspects of ethics and deontology in the activity of a doctor. **Be able to.** to register the data of patients who have applied for medical care in the organization of primary health care; to draw up medical documentation of patients receiving medical care in the organization of primary health care; to make a preliminary appointment of patients for an appointment with doctors; to receive calls from doctors at home; to receive unreasonable calls from the ambulance service during the opening hours of the organization of primary health care and to carry out the transfer of unreasonable calls for emergency medical care; inform the population about the order of work of the polyclinic, about the time and place of reception of the population by the chief physician, his deputies, doctors of all specialties, about the scope of diagnostic studies in the polyclinic. **To own:** to form a register of the attached population, including in electronic format; to carry out the selection and delivery of medical documentation to doctors' offices; to ensure proper management and storage of the card file to regulate the intensity of the population flow in order to create a uniform load of doctors.
3	Special competencies	Information and communication technologies in medicine	4 semester	**To know:** medical and clinical information technologies implemented in the Republic of Kazakhstan; the main problems of automation of health protection in the Republic of Kazakhstan; the role of new technologies in medicine; procedural approach and basic programming concepts; basic concepts and

				constructions of high-level programming languages; software development technologies for the healthcare sector, programming methods. **Be able to:** use the basic principles of modern information and communication technologies in the field of medicine; use electronic document management programs and electronic project management in medicine; apply information technology in medicine; establish an accurate diagnosis using medical devices and completely cure the patient. **To own:** about the latest research, developments and technologies in medicine; skills of analysis and selection of optimal methods and technologies of automated information processing in medicine.
		Medical Informatics		**To know:** theoretical foundations of medical informatics; computer applications for solving problems of medicine and healthcare. Computer support for the work of doctors of various specialties; they allow to improve the quality of preventive and laboratory diagnostic work, especially in the conditions of mass service with a shortage of time of qualified specialists. **Be able to:** use modern software tools to solve problems of evidence-based medicine, automation of clinical trials, informatization of management in the healthcare system; use a medical information system for diagnosis, prevention, treatment and rehabilitation in the clinic of internal diseases. Research of information processes in medicine; development of new information technologies of medicine; solution of scientific problems of creation and implementation of computer technology in medicine. **Possess:** the theory of medical informatics, as well as the practice of applying modern information technologies in the application to medicine and healthcare. medical documentation and information processing; medical terms and classifications; health information systems; data protection and security; access to medical knowledge; medical signal processing.
4	Special competencies	Computer-aided design systems in medicine	5 semester	**To know:** the composition, structure and types of CAD software; the possibilities of automating the design process; the basics of computer-aided design systems in the development of production layouts; organization of work on computer-aided design; classification of computer-aided design and production systems; composition, structure of computer-aided design and production systems; modern CAD systems, their capabilities in the design of devices; CAD/CAM/CAE-systems of SolidWorks, Autodesk Inventor, KOMPASAskon; interaction with the database and knowledge base of automatic design systems; basic principles of operation in a wide range of CAD

				software products. **Be able to:** edit texts in AUTOCAD, use presentation management tools, work with splines, apply 3D-Orbit mode and create typical three-dimensional objects, apply editing orders; use computer-aided design systems at all stages of design; create drawings of parts and assembly drawings, assembly parametric drawings; customize the interface for specific user purposes; apply studied techniques and methods for creating drawings; create 3D models, parametric 3D models of parts; create 3D assemblies, parametric 3D assemblies; create drawings of parts and assembly drawings based on 3D models; use specialized modules of the CAD system under study to carry out strength calculations of the designed ones. structures. **Possess:** the capabilities of modern CAD application software packages; the AutoCAD graphic editor; use automation tools in technological calculations; skills in using the capabilities of modern computers and information technologies in computer modeling.
	Automation of production		**To know:** the concept of automated information systems; characteristics of information systems, types of information systems, the purpose of information systems; the structure of AIS, processes and stages of the life cycle of AIS; principles and stages of designing information systems; requirements for basic resources for the implementation of the information system project; Calculation of additional costs for delivery, etc.; creation of a customer order and transfer it to an adjacent production and/or procurement management information system **Be able to:** select the necessary hardware and software suitable for the specific needs of the information system; analyze, model and design information systems of various architectures; certification of objects with any number of parameters, including linear type objects; registration of equipment operating time counters; assessment of total costs for technological systems, positions, repair facilities, as well as their locations; tracking warranty obligations and making claims on them; **Possess:** about various technologies and methods of design of automated information systems (AIS); analysis of performance, reliability and economic efficiency of automatic lines.
5	Special competencies	Medical Electronics	5 semester	**To know:** the theoretical foundations of obtaining, collecting, entering, storing, searching, processing, converting, distributing and protecting medical information, types and classification of modern medical information systems, the essence and main provisions of the use of modern information technologies

		Fundamentals of designing medical devices and systems		and videoconferencing in medicine, medical science and healthcare, the current state of the level and directions of development of computer technology and software funds for use in the field of medicine. **Be able to:** use various types of modern medical information and telemedicine systems for professional activities, assess the legality, legitimacy and effectiveness of using modern medical information and telemedicine systems for professional activities, work with software tools for solving medical problems. **Possess**: terminology related to modern computer technologies applied to solving problems of medicine and healthcare; the ability to search, store, process and analyze information from various sources and databases, present it in the required format using information, computer and network technologies.
				Know: how to search, store, process and analyze information from various sources and databases, present it in the required format using information, computer and network technologies; import and process analysis results from laboratory instruments. **Be able to:** search, store, process and analyze information from various sources and databases, present it in the required format using information, computer and network technologies; keep a medical history of patients in electronic form; Automate statistical reporting; keep records of the organization's material resources; configure user access rights to various system resources **Possess**: the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies. Development of tools for metrological support of diagnostics and repair of biomedical equipment; development of automation tools for biomedical systems; development of software for solving practical problems of medicine, including the above-mentioned problems; development of tools for designing and manufacturing equipment; development of management tools for medical institutions, the activities of medical personnel.
6.	Special competencies	Medical statistics	5 semester	**To know:** about the essence, basic concepts, principles and methods of medical statistics, in the field of application of statistics in solving problems of public health and healthcare; about the methodology, planning and organization of statistical observation (forms, types, methods and stages of statistical observation); about the essence, application, calculation methods and fundamentals of analysis of descriptive statistics; about the rules of registration

			and presentation of the results of statistical observation; about the basic methods of calculating the health indicators of the population (basic demographic indicators and morbidity); about the main methods of calculating the performance indicators of outpatient clinics and hospitals. **Be able to:** formulate the goals and objectives of the study; plan, organize and conduct statistical observation in accordance with the tasks set; use tabular and graphical methods of presenting statistical observation materials; formulate conclusions arising from the results of statistical observation, and give a generalizing conclusion on them. **Possess:** public speech, argumentation, discussion and polemics; the ability to expand and deepen the scientific worldview; the ability to independently acquire and use new knowledge.	
		Health system statistics	**To know:** about the essence, basic concepts, principles and methods of medical statistics, in the field of application of statistics in solving problems of public health and healthcare; about the methodology, planning and organization of statistical observation (forms, types, methods and stages of statistical observation); about the essence, application, calculation methods and fundamentals of analysis of descriptive statistics; about the rules of registration and presentation of the results of statistical observation; about the basic methods of calculating the health indicators of the population (basic demographic indicators and morbidity); about the main methods of calculating the performance indicators of outpatient clinics and hospitals. **Be able to:** formulate the goals and objectives of the study; plan, organize and conduct statistical observation in accordance with the tasks set; use tabular and graphical methods of presenting statistical observation materials; formulate conclusions arising from the results of statistical observation, and give a generalizing conclusion on them. **Possess:** public speech, argumentation, discussion and polemics; the ability to expand and deepen the scientific worldview; the ability to independently acquire and use new knowledge.	
7.	Special competencies	Artificial intelligence in medicine	5 semester	**To know:** fundamentals and principles of artificial intelligence; machine learning technologies and their application in medicine; principles of processing and analysis of medical data; examples of the use of artificial intelligence in various fields of medicine; basic algorithms and methods of artificial intelligence used in medical research and practice; safety and ethical issues associated with the use of artificial intelligence in medicine.

				Be able to: apply machine learning methods to analyze medical data; develop and implement machine learning models for diagnosing and predicting diseases. Evaluate the effectiveness and accuracy of artificial intelligence algorithms in medical applications; integrate and adapt existing artificial intelligence solutions and technologies into medical practice; design and conduct research aimed at developing and optimizing artificial intelligence systems in medicine. **Possess:** programming skills in languages used to develop and implement artificial intelligence algorithms; ability to work with large volumes of medical data and use them to build machine learning models; skills in analyzing and interpreting results obtained from the application of artificial intelligence methods in medicine; communication skills for effective interaction with medical specialists and other participants in projects to introduce artificial intelligence into medical practice; problem solving and data-driven decision making skills in the context of medical applications and research.
		Artificial intelligence technology in medicine		**To know:** the main stages of the development of intelligent technologies; on the correlation of the discipline "artificial intelligence technologies" of its subject and methods with such areas as mathematical statistics, data mining, machine learning, computer vision, optimization methods, discrete mathematics; the main stages of the construction and functioning of machine learning methods; principles of the construction and functioning of intelligent computer software for medicine; **Be able to:** create intelligent computer systems; Design and create intelligent computer software; use methods of statistical image analysis; use methods for analyzing multidimensional data; to use the basic provisions of the theory of precedent-based learning, to use methods of reducing the dimensionality of data and selecting informative features, to use clustering methods, to use classification methods, to use regression analysis methods; to use the capabilities, conditions of applicability and properties of the most common machine learning methods in the construction, quality control and operation of formal mathematical models; **Possess:** fundamental knowledge of the basics of machine learning theory and practical skills in designing artificial neural networks, building and interpreting formal mathematical models in medicine; information processing technology using the method of decision trees, random forest, logistic regression, artificial neural networks to solve the problems of modern medicine;; designing artificial intelligence systems based on high-level software tools.

8	Special competencies	Modern medical information systems and telemedicine	6 semester	**To know:** the essence and main provisions of the use of modern information technologies and videoconferencing in medicine, medical science and healthcare; theoretical foundations of obtaining, collecting, entering, storing, searching, processing, converting, distributing and protecting medical information, types and classification of modern medical information systems; telemedicine consultations for patients; remote biomonitoring. **Be able to:** use various types of modern medical information and telemedicine systems for professional activities; provide highly qualified and timely medical care to remote patients; use and apply telecommunications in order to connect specialists with hospitals, clinics, and other doctors. **Possess:** basic technologies and equipment for converting audio-video and other types of biomedical information using graphic, text, tabular editors and applications, searching for it on the Internet; controlled by the use of videoconferencing in healthcare.
				To know: the basic principles of medical technology; the structure of technological processes in medicine; optimization of models of medical technological processes, in terms of reducing the costs of their implementation. Creation of components of information systems, production of programs and software complexes; testing and debugging of software complexes of information systems; installation, configuration and administration of network services of computer networks; - certification of objects of professional activity. **Be able to:** work with medical and technical equipment used in working with patients; carry out treatment and ensure maximum compliance with scientifically predicted results with real ones while minimizing costs; apply diagnostic technologies for the treatment of patients. Designing the architecture of information system components; designing the human-machine interface of hardware and software complexes; design of mathematical, information, software and technical support of information systems based on modern methods, tools and technologies of design, including the use of computer-aided design systems. **Possess:** own computer equipment, receive information from various sources, work with information in global computer networks: improves the quality of patient care; provides convenient and quick access to large volumes of medical information; apply the capabilities of modern information technologies to solve professional problems in medicine.

| 9 | Special competencies | Information systems of medical technological processes | 7 semester | **To know:** sound theories of management in healthcare; about the main stages of development of management as a science and art; about the functions, organizational structures of management in healthcare; about the basic and methods of planning and system of public health protection; about the essence, content, typology, methods of managerial decision-making and its acceptance algorithm; about methods and principles of personnel management in medical organizations; about organizational, economic and financial aspects of health care management; about the principles of quality management in health care. **Be able to:** determine the goals and form the tasks of the organization's activities, the collective health system; conduct an assessment of the external and internal environment of the medical organization; apply management methods in the practical activities of the health manager; use information about the health of the population and the activities of the organization to offer measures to improve the quality and effectiveness of medical and preventive care; apply information technologies in the management activities of the health manager; form the work plans of the organization of the team; apply effective communication in the management system in healthcare; use external and internal motivation in the management of human resources in medical organizations. **Possess:** fundamentals of planning in the healthcare system; fundamentals of organization and management in the healthcare system; fundamentals of coordination of activities in the healthcare system; fundamentals of monitoring and evaluating results in the healthcare system; designing organizational structures in healthcare. |

		Management in healthcare		**To know:** Marketing in the field of healthcare, basic principles of healthcare management, methods of healthcare management, basic functions of healthcare management, general concepts of economic management methods in healthcare, features of economic relations in the healthcare system: current state of the problem, the main provisions of the regulated market model in healthcare, payment methods for outpatient care, payment methods for inpatient assistance, types of economic analysis in healthcare. **Be able to:** determine the goals and form the tasks of the organization's activities, the collective health system; evaluate the external and internal environment of the medical organization; apply management methods in the practical activities of the health manager; use information about the health of the population and the activities of the organization to offer measures to improve the quality and effectiveness of medical and preventive care; apply information technologies in the management activities of the health manager; form the work plans of the organization of the team; apply effective communication in the management system in healthcare; use external and internal motivation in the management of human resources in medical organizations. **Possess:** fundamentals of planning in the healthcare system; fundamentals of organization and management in the healthcare system; fundamentals of coordination of activities in the healthcare system; fundamentals of monitoring and evaluating results in the healthcare system; designing organizational structures in healthcare.
10	Special competencies	3D modeling in medicine	7 semester	**To know:** types of computer graphics; basics of working in the Flash Professional program; types of effects of vector objects; possibilities of processing vector text. **Be able to:** create and configure various types of animation in the Flash Professional program; apply basic processing and information algorithms to solving applied problems. **Possess:** programming skills in the Flash Professional environment. methods and means of creating modern multimedia products; basic techniques for creating, converting and editing multimedia data; skills of combining multimedia information into a single information space.

		Graphic images in medicine and healthcare		**To know:** basic concepts and types of computer graphics; color models used in various types of computer graphics; algorithms and types of compression of graphic images; fundamentals of computer modeling; features and applications of the studied software products; fundamentals of web design. **Be able to:** create and process computer graphics in an optimal way; work with basic two-dimensional and three-dimensional graphic editors; design web pages in accordance with the terms of reference, using site design technologies. **Possess:** basic techniques for creating and editing images in vector editors; skills for editing photorealistic images in raster editors.
11	Special competencies	Data Science and neural networks in medicine	7 semester	**To know:** the concept, types and types of data, methods of data collection and preparation for analysis; the content and sequence of stages of the analytical project; modern experience in solving problems of big data analysis in medicine; data analysis apparatus: statistical analysis, semantic analysis, image analysis, machine learning, cluster analysis, factor analysis, classification trees, neural networks; methods of processing quantitative and qualitative data in medicine; features of data processing and analysis tasks for which artificial intelligence technologies are used; tools for data processing and analysis in medicine; the concept of uncertainty of initial data and its types; models and methods of solution taking into account the uncertainty of conditions and limitations in applied problems; methods of information retrieval in healthcare. **Be able to:** conduct a comparative analysis of methods and tools of data analysis in medicine; solve problems of clustering, regression, forecasting, dimensionality reduction and ranking of data; manage information and data when solving applied problems in medicine; adapt to new tasks, new conditions; conduct a comparative analysis of models, methods and tools of data analysis to solve applied tasks taking into account uncertainty; apply critical thinking when choosing methods and tools for solving problems in medicine. **Possess:** the use of various medical data analysis tools to solve problems; the use of models and methods to solve data analysis problems in medicine; the skills of searching for general medical information in solving applied problems; the skills of using various tools in solving problems in the medical environment.
				To know: basic concepts and categories of information technologies; basic methods and methods of obtaining and storing information; basic methods and means of processing information; features of working with big data; methods

| | | Big Data | | for solving problems of processing and analyzing big data, the capabilities of high-performance computing systems, distributed computing technologies, methods and models of Data Mining.
Be able to: develop and analyze conceptual and theoretical models of applied big data analysis tasks; use and apply in-depth knowledge in the field of big data processing and analysis; estimate the time and necessary hardware resources to solve data analysis and processing tasks; create algorithms for analyzing and processing large amounts of data using Data Mining models.
Possess: skills of obtaining information from various sources; skills of working with hardware and software for processing big data; skills of analyzing large amounts of data. skills in using software systems designed for big data analysis. |

Table 2. Mastering the disciplines of socio-professional interactionsequence

Cours e	Provided disciplines	Competences	Expected result
General education subjects			
Mandatory component			
1	History of Kazakhstan	Competencies of general education	**To know:-** demonstrate knowledge and understanding of the main stages of the development of the history of Kazakhstan; **Be able to:-** to correlate the phenomena and events of the historical past with the general paradigm of the world-historical development of human society through critical analysis; be able to objectively and comprehensively comprehend the immanent features of the modern Kazakh model of development; **Possess: -**possess the skills of analytical and axiological analysis in the study of historical processes and phenomena of modern Kazakhstan; -to systematize and give a critical assessment of historical phenomena and processes of the history of Kazakhstan
1	Foreign language	Competencies of general education	**To know**:- lexical minimum and language material of topics and subtopics in this discipline (social and household and socio-cultural spheres of communication). **Be able to:-** understand by ear not only individual phrases and frequently used words, but also more voluminous statements on topics directly related to him, - - understand the main content of short simple messages on the radio, at the airport, at the train station. - understand when reading the content of short, simple texts, advertisements, brochures, menus, bus and train schedules, a short, simple personal letter, e-mail. - communicate in simple typical situations that require the exchange of information within familiar topics and activities, be able to talk about family, living conditions, educational classes. - write a simple personal letter, a note, an autobiography. **Own:-**understanding of foreign-language dialogic and monologue speech within the framework of general cultural and professional topics; - a foreign language at the level that allows you to carry out the main types of speech activity; - various ways of oral and written communication; - skills of adequate response in situations of everyday, academic and professional communication;

			- listening, reading, writing skills.
1	Kazakh (Russian) language	Competencies of general education	**To know:** - theoretical foundations of the course (language, its functions, forms of speech, text, its features, speech styles, functional and semantic types of speech); - features of dialogic and monologue speech; - types of scientific information and specifics of its implementation in a scientific text; - elements of structural and semantic analysis and semantic analysis of a scientific text, components of the speech situation, the speaker's intentions. **Be able to:-** to make the right choice and use of language and speech means to solve certain problems of communication and cognition on the basis of knowledge of a sufficient volume of vocabulary, a system of grammatical knowledge, pragmatic means of expressing intentions; - to compose everyday, socio-cultural, official and business texts in accordance with generally accepted norms, functional orientation, using lexico-grammatical and pragmatic material of a certain certification level that is adequate for the set goal; - to convey the factual content of texts, formulate their conceptual information, describe the deductive knowledge (pragmatic focus) of both the entire text and its individual structural elements; - interpret the information of the text, explain the stylistic and genre specifics of the texts of socio-cultural, socio-political, official-business and professional spheres of communication in the scope of certification requirements; - to participate in communication in various situations of different spheres of communication in order to realize their own intentions and needs (domestic, educational, social, cultural), stating them ethically correctly, meaningfully fully, lexically-grammatically and pragmatically adequate to the situation; - discuss ethical, cultural, socially significant issues in discussions, express your point of view, defend it with reasoned arguments, critically evaluate the opinion of interlocutors; - to build programs of speech behavior in situations of personal, social and professional communication in accordance with the norms of language, culture, specifics of the sphere of communication, certification requirements; - request and report information in accordance with the communication situation, evaluate the actions and actions of participants, use information as a tool to influence the interlocutor in situations of cognition and communication in accordance with certification requirements. **Own:-** skills of producing oral and written speech in accordance with the

			communicative purpose and professional sphere of communication; - language skills in various situations of everyday, socio-cultural, professional communication; - skills of searching, processing information in Russian; - types of speech activity
1	Information and communication technologies	Competencies of general education	**To know: -** what economic and political factors contributed to the development of information and communication technologies; - features of various operating systems, architecture. **Be able to: -** identify the main trends in the field of information and communication technologies; - use information resources to search and store information; - work with spreadsheets, consolidate data, build graphs; - apply methods and means of information protection; design and create simple websites; - process vector and raster images; create multimedia presentations; use various platforms for communication; - calculate and evaluate performance indicators of supercomputers; - use various forms of e-learning to expand professional knowledge; - use various cloud services. **Own: -** database structure development; - designing and creating presentations; - receiving data from the server; - creating video files; - work with Smart applications; - work with services on the website of the electronic
2	Philosophy	Competencies of general education	**Know: -** basic philosophical concepts and categories, patterns of development of nature, society and thinking; - the essence of philosophical categories, terminology of philosophy and the structure of philosophical knowledge, functions of philosophy methods of philosophical research; - the place and role of philosophy in public life; **Be able to:-** to use the basics of philosophical knowledge to form a worldview position; - analyze ideological, socially and personally significant philosophical problems; - to orient oneself in the system of philosophical knowledge as a holistic view of the foundations of the universe and the prospects for the development of planetary society; - to understand the characteristic features of the modern stage of philosophy development **Own:-** skills of philosophical analysis of various types of worldview; - the skills of philosophical thinking to develop a systematic, holistic view of the problems of society;

			- skills of analyzing texts with philosophical content
1	Political science	Competencies of general education	**To know:-** the main stages of the development of political knowledge in the history of civilization; - schools and directions of modern political science; - political life of society; - the political system and its institutions; - the essence of political processes in the country and the world. **Be able to:** -analyze the features of political systems and the functioning of political institutions; - critically evaluate the theoretical approaches of political science; - to identify the interrelationships and patterns of the political process; - compare political systems, institutions and actors in an inter-country and subnational context, based on the knowledge gained and the methods mastered. **Possess: -** Have the skills (gain experience) of working with primary sources on the topics of the course; analysis of regulatory legal acts and other documents; search, processing and analysis of information; solving problems related to the assessment of the political course; working in groups, project activities, business games; public speaking; academic writing.Have the skills to express their thoughts and opinions in interpersonal and business communication in a foreign language; the skills to extract the necessary information from the original text in a foreign language.
1	Sociology	Competencies of general education	**To know:-** patterns and stages of the historical process, the main historical facts, dates, events and names of world and domestic historical figures; - the main events and processes of national history in the context of world history **Be able to: -** critically perceive, analyze and evaluate historical information, factors and mechanisms of historical changes; - analyze civil and ideological positions in society, form and improve their views and beliefs, transfer philosophical worldview to the field of material and practical activities; - use various philosophical methods to analyze trends in the development of modern society, philosophical and legal analysis **Own:-** skills of a holistic approach to the analysis of society's problems; - methods of philosophical, historical and cultural studies, techniques and methods of analyzing the problems of society; - causal relationships in the development of Kazakhstan society; the place of a person in the historical process and the political organization of society; skills of respectful and careful attitude to the historical heritage

| 1 | Cultural Studies | Competencies of general education | **To know: -** basic theories of culture, basic concepts of cultural studies; the main directions of the methodology of modern cultural analysis;
- the history of the formation of world culture and civilization, theoretical features of basic cultural concepts, various interpretations of culture and civilization in world and domestic literature;
- actual problems of the development of modern culture;
- the idea of culture as a socio-historical phenomenon;
- patterns of the development of world cultures, as well as the typology of the classification of cultures;
-basic knowledge about the history of the most important cultures of mankind;
- about the ways of acquiring, storing and transmitting the basic values of culture - about the diversity and self-worth of various cultures,
- forms and types of culture, patterns of their functioning and development, the main cultural and historical regions - the history of Kazakh culture, its place in the system of world culture and civilization
Be able to: - be able to highlight the features of this culture, the dominant values in it;
- explain the specifics of intercultural communication;
- be able to conduct independent professional activity in a dynamically changing multicultural society;
- be able to navigate the cultural environment of modern society;
- be able to explain the phenomenon of culture, its role in human life;
- be able to navigate cultural issues, independently understand the issues of the influence of cultural factors on the behavior of individuals;
Own:- practical skills in the preservation and enhancement of national and world cultural heritage;
- practical skills of practical use of knowledge and skills in taking into account the specifics of cultural behavior of various individuals and collectives in the modern conditions of the formation of civil society in the Republic of Kazakhstan. |
| 1 | Psychology | Competencies of general education | **To know:** the meaning and place of psychology in the system of sciences; the main directions of personality development in modern psychology; personal values and meanings in professional self-determination; the relationship and mutual influence of the psyche and body; techniques and techniques of effective communication.
Be able to: interpret basic psychological theories, concepts; use methods and mechanisms of emotion regulation in everyday life; identify patterns of behavior in a conflict situation and conduct self-diagnosis. |

			Possess: definitions of individual psychological characteristics of personality, value-semantic concepts in professional self-determination of personality; recognition of psychological impact and effective communication
General education disciplines		
University component		
1	Fundamentals of economic and legal knowledge	Competencies of general education	**To know:** methods of scientific research in economics, various theories about entrepreneurship, financial literacy and market economy, types of entrepreneurship, entrepreneurship, to learn various quantitative and qualitative methods for creating a future business, entrepreneurial calculations, analytical calculations and forecasts, the main provisions of the Constitution and current legislation of the Republic of Kazakhstan, the system of public administration and the circle their powers, the mechanism of interaction of substantive and procedural law, the essence of corruption and the reasons for its origin, the current legislation in the field of anti-corruption. **Be able to:** analyze and substantiate the reality of business plans, market segmentation, competently and professionally assess the market situation for the organization of their business, creatively approach the solution of various economic tasks, possess practical skills of independent economic work in the field of entrepreneurship, calculate personal budget, have clear background information and a quick and correct orientation to economic indicators, analyze events and actions from the point of view of the field of legal regulation and be able to refer to the necessary regulations, navigate the current legislation, using the law to protect their rights and interests, use spiritual and moral mechanisms to prevent corruption. **Possess:** acquire practical skills in constructing graphs and diagrams illustrating various economic models, independently conducting economic work in the field of entrepreneurship, quickly and correctly navigate the actual source information and calculated economic indicators, determine the levels of financial security, have the skills to identify economic problems when analyzing specific situations and their solutions, taking into account the actions of economic patterns on micro-and macro-levels, conducting discussions on legal issues, on the application of norms in the modern period, analyzing the situation of conflict of interests and moral choice.
	Basis of scientific and ecological thinking		**To know:** forms and methods of pre-scientific, scientific and extra-scientific cognition, modern approaches to socio-humanitarian knowledge and their commensurability; basic epistemological models, the nature of transformations of the concept of rationality; fundamentals of ecology and safe human activity in the habitat, environmental factors and their impact on living organisms, methods for

			identifying, eliminating the influence of harmful factors on humans and the environment, and providing comfortable conditions for human life and activity. **Be able to:** formulate and solve problems that arise in the course of research and require in-depth professional knowledge; modify existing and develop new methods based on the objectives of a specific study; choose methods of protection from hazards in relation to the field of their professional activities and choose ways to ensure comfortable living conditions. **Possess:** the skills of conducting independent research and scientific and pedagogical activities that require extensive education in the appropriate direction; the ability to apply methodological and methodological knowledge in conducting scientific research; the skills to ensure the safety of life in professional activities, living conditions and in emergency situations.
Basic disciplines			
Required component			
1	Physics I	Basic competencies	**To know:** basic physical theories, laws and principles and their mathematical expression; the possibility of applying theoretical knowledge to solve specific physical problems and situations; basic laws and principles of physics; **Be able to:** mathematically represent physical laws; apply theoretical knowledge to solve specific physical problems of the situation; determine the physical essence of phenomena and processes in various devices of physical nature and perform simple technical tasks relative to them; work with measuring instruments, instruments and instruments; graphically perform the information obtained during observations and carry out statistical processing; **Possess skills:** work with measuring instruments, devices; perform statistical processing of the results of observations and measurements and perform graphical understanding;
1	Mathematics I	Basic competencies	**To know**: basic mathematical definitions, theorems, etc. theoretical information of the course "Mathematics I", as well as types of problems solved by mathematical methods; **Be able to:** form applied practical problems using mathematical methods, as well as apply well-known methods to solve formulated problems; **Possess skills:** independently or in order to meet the modern requirements of the profession to improve their qualifications in the field of mathematical knowledge;
1	Mathematics II	Basic competencies	**To know:** properties of functions of several variables: (limitation, presence of the largest and smallest values, complex functions, partial multiplications and derivatives, full multiplications and differentials; basic methods of integration of

			double and triple integrals (substitution of variables, calculation in polar coordinates); types of differential equations and methods of their solution; methods for determining power series of functions. and Fourier series decomposition; apply basic formulas to calculate the probability of random variables; **Be able to:** apply methods for solving differential and integral calculus of functions of several variables in applied problems; apply methods for solving differential equations in solving applied problems; obtain approximate values of solutions by decomposing into a power series and a Fourier series with a given accuracy; determine optimal methods for solving practical problems. **Possess skills:** solve engineering problems using mathematical methods;
2	Algorithms, data structures and programming	Basic competencies	**Know:** algorithmic methods of algorithms; structural features, organization and practical implementation of algorithms; fundamentals and prospects for the development of new technologies. **Be able to:** Consider the properties of algorithms and situations in which these algorithms can be useful; build various programs using fundamental computational algorithms and their properties leading to linear, branched and cyclic type of algorithms; processing arrays using various internal sorting methods; research related to the analysis of algorithms; analysis of the effectiveness of algorithms; practical use construction of models and data structures, subsequent analysis of the results obtained. **Possess skills:** development of algorithms and programs for solving problems; practical work on the use of modern software, modern computer technology;
2	Professional Kazakh (Russian) language	Professional competencies	**Know:** scientific vocabulary of technical profile and scientific structures; rules for the representation of texts of various genres; language norms in the field of technical activity; fundamentals of business communication; **Be able to:** choose language means, build statements taking into account literary norms and the communicative situation; distinguish between the logical and compositional structure of a scientific test, possess oral public comments (message, report), analyze publicly listened statements; carry out professional communication; use dictionaries and talk about the language units obtained from them correctly interpret information; extract the read or listened text from the educational, professional, socio-cultural spheres, indicating the necessary information and presenting it in a certain sequence; **Possess:** work with scientific and technical literature; independent search for scientific and technical information as the basis of professional activity; listening and full understanding of the claimed information at a normal pace with subsequent

			transmission of its content; conducting dialogues interview requests and conversations;
2	Professionally oriented foreign language	Professional competencies	**To know:** functional features of oral and written texts of a scientific and technical nature in the specialty; requirements for the preparation of documents accepted in professional communication; strategy of communicative behavior in professional communication; **Be able to:** understand oral speech within the framework of a professional topic; participate in the discussion of topics related to the profession; independently prepare and create oral messages on professional topics using multimedia technologies; receive the necessary information from foreign language sources created in various sign systems (text, table, chart, audiovisual series, etc.); annotation, abstracting and presentation in the native language of the main content of literature in the specialty using a dictionary, if necessary; writing messages, articles, theses, abstracts on professional topics. **Possess**: basic grammatical constructions characteristic of oral and written professionally-oriented communication;
Component of choice			
2	Database in IP / Database concept	Professional competencies	**To know:** the basic concepts of the relational data model; the internal organization of modern multi-user DBMS; the basics of the relational database language SQL; database design technology at the conceptual and logical levels of data manipulation languages (QBE, DML SQL), basic functions and typical organization of database management systems (DBMS). **Be able to:** build a logical and physical model of the projected database; design databases in various DBMS and program work with them; create reports, forms, queries; conduct multidimensional data analysis; organize the user interface. **Possess**: to build a logical and physical model of the projected database; to design databases in various DBMS and program work with them; to create reports, forms, queries; to carry out multidimensional data analysis, implement queries for sampling, insertion, deletion, correction of records in tables.

			To know: about the principles of organization and architecture of database systems; data models; sequence and stages of database design; modern methods of synthesis and optimization of database structures; basic concepts of the data processing language (SQL); modern methods of ensuring data integrity; methods of physical organization of databases; trends and prospects for the development of modern database management systems data; about the main unsolved problems that arise during the creation and use of databases. **Be able to:** apply modern methodology for research and synthesis of information models of AIS subject areas; apply modern methodology at the stage of technical design examination, selection and system justification of design decisions on the structure of information models and databases; design databases (from the stage of analysis of the subject area of an information system to the implementation of a physical database model); apply design methods databases and database interaction programming; implement and document database-based AIS. **Possess:** working with relational databases in SQL; database design work: analyzing the subject area of an information system, compiling an infological model and a datalogical (conceptual) database schema, determining integrity constraints and data access rights, using data protection tools; using the "essence of communication" (ER-method, method "entity-relation") for database design.
2	Operating systems / Operating systems and PC software	Professional competencies	**To know:** basic principles of operating system design; purpose, function, classification of operating systems; principles of operating system computing resources management; the concept of multi-programming, processes and threads; principles of virtualization and mobility of the operating system. **Be able to:** implement basic algorithms for scheduling and synchronizing processes and threads; manage memory; plan disk scheduling; edit multithreaded applications; take into account the specifics of working in specific operating systems; use operating system tools. **Possess::** install operating systems; manage accounts; configure working environment parameters; configure hardware; manage disks and file systems; configure network parameters
			To know: the basic architectural concepts of building and distributions of operating systems; the main components of operating systems, their purpose and relationship; mainframe operating systems; server operating systems; operating systems for personal computers; real-time operating systems. **Be able to:** review computer software; provide operating system service; create system calls, system programs; select the operating system according to its purpose

			and characteristics; select the operating system distribution and install it on a personal computer; provide basic configuration of the operating system in the environment of its functioning. **Possess:** skills of solving typical tasks of system programming of modern operating systems; skills of working with various operating systems and their administration, solving practical tasks to support the operation of the operating system.
2	Fundamentals of robotics and Artificial intelligence / robotic systems and complexes	Professional competencies	**To know:** mathematical models of automation systems and robotization of production processes using modern data software products; methods of constructing algorithms aimed at the structure. **Be able to:** design automation and robotics systems; comparative analysis with the use of modern software products for the robotization of technological complexes and automation systems of production processes in various industries, as well as artificial intelligence methods. **Possess skills:** formation of modern trends in the development of robotics systems and automation of production processes
			Know: industrial robot control systems; about remotely controlled robots; **Be able to:** use of robotic systems training in solving programming problems. **Possess:** information processing; organization of work on the collection, storage and processing of information used in the field of professional activity.
3	Methods and tools for program development/ Database Programming	Professional competencies	**To know:** the basic principles and methodologies of software development; programming languages and development environments used in the medical field; basic methods of analysis and processing of medical data; principles of information systems in healthcare; the main problems and requirements specific to IT in medicine; **Be able to:** develop healthcare software, taking into account the specifics and requirements of the industry; design and implement medical information systems; apply data analysis methods to extract useful information from medical datasets; work with medical standards and protocols; test and debug software, ensuring its reliability and security; **Possess:** programming skills in languages used in the medical field, such as Python, Java, SQL and others; working with databases and database management systems used in healthcare; ability to work in a development team and other participants in healthcare IT projects; the ability to adapt to new technologies and tools related to IT in medicine; communication skills for effective interaction with medical specialists and software customers.

			To know: the main tools and environments of software development; principles and methods of integrating various tools into the development process; modern technologies and platforms for software development; the main stages of the software lifecycle; standards and best practices in the field of software development; **Be able to:** use tools for writing, debugging and testing software code; configure and manage integrated development environments (IDEs); apply version control tools for source code management; automate software assembly and deployment processes; evaluate and select appropriate tools for solving specific tasks in the development process; **Possess:** skills in working with basic software development tools and technologies; the ability to effectively use the IDE for software development; the ability to apply version control tools in teamwork; practical skills in configuring and using automation systems for assembly and deployment; competencies in selecting and integrating various tools to optimize the software development process.
3	Information Systems Software / Information Systems Programming	Professional competencies	**To know:** methods and means of software design and software interfaces; methods and means of database design; functional and technical software design; principles and types of software architecture construction; methods and principles of information security; installation and maintenance of server and client software in AIS; basic principles and software development tools of AIS. **Be able to:** choose and apply the basic principles of software design; develop documentation of software and database software interfaces; develop preliminary versions of software user documentation; describe software components and interfaces between them, for their subsequent coding and testing; generate documentation reports on the results of the work carried out; install, adapt, maintain and operate standard AIS software. **Possess skills:** about the variety of instrumental and applied software tools, problems and prospects of software development.
			To know: terminology of the discipline, methods and technology of object-oriented programming, abstractions of basic data structures and methods of their processing and implementation, basic data processing algorithms, basic libraries of standard programs. **Be able to:** apply programming methods in the development of information systems, determine data structures when designing algorithms in the process of solving problems, develop algorithms, split the solution of a complex problem into a sequence of simpler tasks and implement algorithms in a high-level programming

			language; use libraries of standard programs that are included in the programming language. **Possess skills:** methods and technologies for developing algorithms, describing data structures and other basic data representations, programming in a high-level language, working in various programming environments.
3	Biostatistics / Statistical analysis in healthcare	Professional competencies	**To know:** about the types of data and ways of their presentation; about the changing scales; about the criteria of compliance and consent; about the types of systematic errors and their assessment in research; about the properties of the law of normal distribution of signs; about the analysis of variance; about correlation dependence; about the criteria for testing hypotheses; about the Student's t-criteria; about the main criteria of epidemiological analysis, epidemiological indicators; about the stages of a medical and biological experiment, planning; about the analysis of survival. **Be able to:** apply statistical processing methods; assess the reliability and reliability of measurements in biostatistics; identify differences in statistical significance; obtain units for the selected set; determine the distribution of statistical series, and assess their compliance with the laws of theoretical distribution. determination of the accuracy and reliability of the assessment by time intervals. quantitative characteristics, power, size, one-factor application of basic methods of variance analysis; construction of the viability curve verification of statistical assumptions; correlation sampling coefficient. **Possess skills:** assessment for the interpretation of the methodology of mathematical and statistical analysis, research of the results of medicine and biology; apply statistical methods of data processing.
			To know: about the properties of the law of the normal distribution of signs; about the analysis of variance; about the correlation dependence on the main criteria of epidemiological analysis, epidemiological indicators; about the stages of medical and biological experiment, planning; about the analysis of survival. **Be able to:** identify differences in statistical significance; obtain units for the selected set; determine the evaluation of the distribution of statistical series, and assess their compliance with the laws of theoretical distribution. determination of the accuracy and reliability of the assessment by time intervals. quantitative characteristics, power, size, one-factor application of basic methods of variance analysis; construction of the viability curve verification of statistical assumptions; correlation sampling coefficient. **Possess the skills:** to apply statistical methods of data processing; assessment for

			the interpretation of the methodology of mathematical and statistical analysis, research of the results of medicine and biology.
3	Audit information security / Information Privacy protection	Professional competencies	**To know:** regulatory legal acts of the Republic of Kazakhstan in the field of information security: regulatory and technical documents on information security: principles, methods and means of ensuring information security in determining business continuity measures, registration and accounting of information security events, backup, antivirus protection, access control, work with removable media, mobile devices, remote access, using cryptography and their carriers, licenses and software versioning; basic concepts and concepts of modern information security technologies; basic methods of creating information security systems; basic standards in the field of information security; basic tools for information protection. **Be able to:** develop coordination of work on (updating) documents regulating the processes of information security (registration and accounting of information security events, backup, antivirus protection, access control, information security when working with removable media, mobile devices, postal services and the Internet, responding to information security incidents, the use of cryptography and their media, management licenses and software versioning); analyze types of attacks and threats to information security; formulate appropriate requirements for information security systems; use information security tools; use information security tools for functional optimization of information systems. **Possess skills:** basic skills of building and managing information security systems; skills of repelling typical attacks on information systems; basic skills of working as a computer system security administrator.
			To know: the methodology for evaluating the results of the application of organizational and technical solutions to ensure information security; the methodology for monitoring the implementation of plans and measures to control the processes of managing and ensuring information security of the organization; basic concepts and directions in the protection of computer information, principles of information protection, principles of classification and examples of security threats to computer systems; **Be able to:** monitor the implementation of an information security plan; analyze the results of inspections of compliance with the requirements of documents regulating the processes of information security and NTD of information security management processes in the organization; participate in the development of confidentiality or

3			non-disclosure agreements with employees of the organization, contractors and third parties; configure built-in security tools in the operating system, analyze computer security and the network environment using a security scanner; install and use one of the means to encrypt information and organize data exchange using an electronic digital signature; **Possess the skills:** methods of information systems security audit, methods of system analysis of information systems.
3	Programming Languages / Programming in a high-level language	Professional competencies	**To know:** terminology of the discipline; basic structures and tools that are used in programming languages, for example C++: basic structures and data types of C++; basic methods in the development of algorithms (recursion, backtracking, method of branches and boundaries, analysis of arithmetic expressions); basic algorithms; dialects of C++, including those used when programming microcontrollers; libraries of standard programs. **Be able to:** apply programming methods in the development of information systems; determine data structures when designing algorithms in the process of solving problems; split the solution of a complex problem into a sequence of simpler tasks **Владеть:** использования библиотеки стандартных программ, которые включены в язык программирования C++; – самостоятельного осваивания языка программирования, который необходимо использовать при решении задач
			To know: the basic syntax of programming languages: Python 3, Ruby, Perl, Go and their capabilities; principles of forming readable code; methods of developing programs "top-down" and "bottom-up"; ideology of modular and object-oriented approach; typical solutions used to create programs; **Be able to:** develop readable programs; use both built-in and online library documentation; connect additional modules and standard modules and packages; apply an object-oriented approach to writing programs; develop programs both individually and in a team, using modern tools for writing and debugging programs. **Possess the skills of:** using integrated development environments (IDE) for writing programs; using an interactive console for interpreted programming languages; basic commands of the git version control system; debugging and introspection of someone else's program code.
4	Modeling of information systems / fundamentals of computer modeling	Professional competencies	**To know:** the principles of building analytical and simulation models of information processes, the main classes of models and modeling methods, methods of formalization, algorithmization and implementation of models on a computer.

			Be able to: reasonably choose a modeling method; build an adequate model of a system or process using modern computer tools; interpret and analyze the results of modeling. **Possess the skills:** methods and techniques of working in CASE-tools; methods and techniques of modeling information systems on modern computers based on an analytical and simulation approach.; the main criteria for evaluating the simulation results.
			To know: standard classes of models and methods of modeling complex systems, the apparatus of the Monte Carlo method, principles of constructing models of the processes of functioning of complex systems, methods of formalization and algorithmization; **Be able to:** use a systematic approach in the research, design and operation of information systems, develop modeling algorithms and implement them using algorithmic languages and modeling application software packages, automate the design process using modeling databases. **Possess skills:** skills of using computer modeling tools to create psychological comfort of the user.
4	Web technologies / programming on the Internet	Professional competencies	**To know:** the basics of the functioning of the World Wide Web; stages of website development; HTML hypertext markup language; technology for separating content and formatting using cascading CSS style sheets; modern technologies for developing websites; the procedure for using server technologies; principles of SEO optimization of websites. **Be able to:** create static HTML pages and apply style sheets; use tools for creating static sites (Web editor, graphic editor, etc.) to create interactive elements of Web pages; develop dynamic Web sites using modern site design technologies. **Possess skills::** hypertext markup language for building HTML documents;
			To know: the technology of creating Web pages using PHP; methods of building modern Internet resources, standards in the field of developing Internet resources, formats for storing graphic information for Internet resources, principles of building client and server components. **Be able to:** develop Web sites of varying complexity using PHP; develop Internet applications using modern development tools **Possess skills:** skills of developing Web resources using PHP.
Professional disciplines / Component of choice			
	Expert systems in medicine /	Professional competencies	**Know:** the use of expert systems in medicine; medical diagnostic system; predictive

4	information and computing expert systems in medicine		system; planning system; interpreting system. **Be able to:** solve problems of diagnosis, differential diagnosis, forecasting, choice of strategy and tactics of treatment; define an expert system (ES) as a software system using expert knowledge to provide highly effective solutions to problems in medicine; use various expert systems in medicine; solve problems that require expert knowledge for their solution; use diagnostic systems for establishing a connection between disorders of the body's activity and their possible causes. **Possess skills:** expert knowledge for solving medical problems; basic methods for the use of medical information systems in the treatment and diagnostic process; software and hardware complexes for the study of diseases of internal organs.
			To know: the definition of an information system, the tasks of medical information and computing systems, classification, functional purpose of medical information and computing systems, the concept of an automated control system in medicine, its levels, components, structure, functions, basic requirements, as well as development steps. **Be able to:** compile and analyze the block diagram of the software package of the automated hospital information system of a medical and preventive institution; enter information about treated patients in the AS Hospital; form a consolidated and personalized account-register for mutual settlements with an insurance medical organization in the AS Hospital; **Possess the following skills:** modern computer tools for creating expert systems in the clinic of internal diseases, modern software tools for processing experimental and clinical diagnostic data, skills for introducing new medical technologies and software and hardware complexes for the study of diseases of internal organs, methods of computational diagnostics and forecasting of the patient's condition.
4	Mathematical methods of evidence-based medicine / mathematical processing of experimental data	Professional competencies	**To know:** the definition of an information system, the tasks of medical information and computing systems, the functional purpose of medical information and computing systems, the concept of an automated control system in medicine, its levels, components, structure, functions, basic requirements, as well as the stages of development. **Be able to:** develop and analyze the block diagram of the software package of the automated hospital information system of a medical and preventive institution; include information about hospitalized patients; generate consolidated and personalized accounts for mutual settlements with the medical organization of the

				AU in the hospital;
				Possess the skills: modern computer tools for creating an examination system in an internal medicine clinic, modern software for processing experimental and clinical diagnostic data, with the introduction of new medical technologies and software and hardware complexes for studying diseases of internal organs, computational diagnostics and methods for predicting the patient's condition.
				To know: the basics of mathematics, physics, computer engineering and programming; basic software development methodologies, relational database design theory, basic software lifecycle models, software testing methods, basic approaches to the software development process. **Be able to:** solve standard professional tasks using natural science and general engineering knowledge, methods of mathematical analysis and modeling; choose a software development methodology depending on the task, design relational databases, choose the most appropriate software lifecycle model, test developed software. **Possess skills:** skills of theoretical and experimental research of objects of professional activity; relational database design skills, software testing methods and techniques, software development team skills, skills in using various technologies and software development tools.
				To know: the regulatory framework for the development and execution of technical documentation; methods of designing automated information systems; typical components of automated information systems; features of the operation of computer networks of various types; principles of building distributed information systems; software composition of automated information systems; methods of ensuring information security of automated information systems; methodology for improving technological solutions; basic methods of quality management of manufactured products and services; methodology for assessing the quality and reliability of manufactured products; -the procedure for certification of manufactured products and services; general principles of personnel management. **Be able to:** develop technological processes of automated information processing, develop, modify, adapt and maintain components of automated information systems; install, adapt, maintain and operate software for automated information systems; make the optimal choice of information software and hardware in the formation and modification of automated information systems; operate automated information systems; to ensure the compatibility of hardware and software protection of computer technology; to develop instructional documentation for the maintenance of

			automated information systems; **Possess the skills:** methodology of domain analysis and design of applied ASOIU; the ability and skills of selecting and verifying various protocols; levels of architecture of the digital network of integrated services, methods of evaluating the effectiveness of specific variants of integrated networks; methods of system analysis of ASOIU interfaces.
4	Methods of medical information processing / software for medical data processing	Professional competencies	**To know:** analysis of the latest achievements in the field of automation of medical information processing; structural analysis of a medical automated information system; a document management automation system for medical institutions, which combines a medical decision support system, electronic medical records about patients, medical research data in digital form, patient condition monitoring data from medical devices, communication tools between employees, financial and administrative information **Be able to:** work with a medical automated information system; develop, modify, adapt and maintain components of automated information systems in medicine; develop instructional documentation on the maintenance of automated information systems in medicine; **Possess the skills:** basic functions of automation of information systems in medicine; principles of building information systems in medicine.
			To know: mastering manual, medical-tactical and communication skills by introducing high-tech robotic dummies and dummies, virtual simulators into the educational process of a medical university in order to improve the quality of practical training of a future doctor. **Be able to:** assess the severity of the patient's condition, determine the volume and sequence of necessary measures to provide assistance, organize emergency care in emergency cases **Possess skills**: manipulation skills for patient care (treatment of the oral cavity, washing, feeding, bedding, dressing, moving, assistance with natural needs)
			Know: basic concepts and categories of information technology; basic methods and means of obtaining and storing information; main ways and means of information processing; features work with big data (Big Data); methods for solving problems of processing and analyzing big data, the possibilities of high-performance computing systems, distributed computing technologies, methods and models of Data Mining. **Be able to:** develop and analyze conceptual and theoretical models of applied problems of big data analysis; use and apply in-depth knowledge in the field of processing and analysis of big data; estimate the time and necessary hardware

			resources for solving problems of data analysis and processing; create algorithms for analyzing and processing large amounts of data using Data Mining models. **Possess skills:** skills of obtaining information from various sources; skills in working with hardware and software for processing big data; skills in analyzing large amounts of data. skills in the use of software systems designed to analyze big data.

Table 3. List of modules included in the educational program

№ of the module	Module name	List of disciplines included in the module	Block	Semester	Volume of loans	Form of control	Total credits by module
M.1	The basics of bilingual literacy	Kazakh (Russian) language	GD/OC	1,2	10	Exam	25
		Foreign language	BD / E	1,2	10	Exam	
		Information and communication technologies	GD/ OC	1	5	Exam	
M.2	Historical and philosophical knowledge	History of Kazakhstan	GD/ OC	2	5	SE	10
		Philosophy	GD/ OC	4	5	Exam	
M.3	Module of socio-political education	Sociology	GD/ OC	2	8	Exam	8
		Political science	GD/ OC	2		Exam	
		Cultural Studies	GD/ OC	1		Exam	
		Psychology	GD/ OC	1		Exam	
M.4	Fundamentals of Economics and Ecology	Fundamentals of economic and legal knowledge	GD /UK	2	3	Exam	5
		Basis of scientific and ecological thinking	GD/ UK	2	2	Exam	
M.5	Physical education and sports	Physical education	GD/ OC	1,2,3,4	8	Dif.offset	8
M.6	Professional communication and management	Professional Kazakh (Russian) language	BD /CC	3	3	Exam	6
		Professionally oriented foreign language	BD /CC	4	3	Exam	
M.7	Functional literacy	Physics I	BD/ M	1	4	Exam	18
		Mathematics I	BD/ M	1	5	Exam	
		Mathematics II	BD/ M	2	3	Exam	
		Fundamentals of information systems	PD/OC	3	5	Exam	
		Educational practice	BD/ M	2	1	Dif.offset	
M.8	Intelligent and robotic systems in medicine and healthcare	Algorithms, data structures and programming	BD/ M	3	5	Exam	31
		Fundamentals of Robotics and artificial intelligence / Robotic systems and complexes	GD/ OC	4	6	Exam	
		Artificial intelligence in medicine	GD/ OC	5	5	Exam	

		Computer-aided design systems in medicine / Production Automation	GD/ OC	5	5	Exam	
		Programming languages / Programming in a high-level language	BD /CC	6	6	Exam	
		3D modeling in medicine / Graphic images in medicine and healthcare	PD/CC	7	4	Exam	
M.9	Software development technologies	Operating systems / PC operating systems and software	BD /CC	3	5	Exam	20
		Work experience I	BD /CC	4	2	Dif.offset	
		Methods and tools for program development / Database programming	BD /CC	5	5	Exam	
		Information Systems Software / Information Systems Programming	BD /CC	6	5	Exam	
		Web technology / Internet programming	BD /CC	7	3	Exam	
M.10	Physical and information technologies in medicine	Medical Physics / Medical physics and medical imaging	PD /CC	3	5	Exam	23
		Medical electronics / Basics of designing devices and systems for medical purposes	PD/CC	5	5	Exam	
		Modern medical information systems and telemedicine/ Information systems of medical technological processes	PD/CC	6	5	Exam	
		Work experience II	BD /CC	6	4	Dif.offset	
		Administration of information systems / automated information processing and management systems	PD/CC	7	4	Exam	
M.11	Mathematical and statistical methods in medicine	Public health and healthcare/ Social medicine	BD /CC	4	6	Exam	30
		Medical statistics / Health system statistics	BD /CC	5	5	Exam	
		Biostatistics / Statistical analysis in health care	BD /CC	6	5	Exam	
		Mathematical methods of evidence-based medicine / Mathematical processing of experimental data	BD /CC	7	4	Exam	
		Expert Systems in medicine / Information and computing expert systems in medicine	BD /BD	7	5	Exam	
		Methods of processing medical information/Medical data processing software	BD /BD	8	5	Exam	
M.12	Databases and IP modeling	Database in IP / Database Concept	BD /CC	3	5	Exam	15
		Database administration on the MS SQL Server platform	PD/CC	5	5	Exam	
		Modeling of information systems /Fundamentals of computer modeling	PD/CC	7	5	Exam	

M.13	Data management and information security in medicine	Information and communication technologies in medicine / Medical Informatics	BD /CC	4	6	Exam	33
		Audit information security / Protection of information privacy	BD /CC	6	5	Exam	
		Healthcare Management / Healthcare Marketing	PD/CC	7	5	Exam	
		Data Science and neural Networks in medicine / Big Data	PD/CC	8	5	Exam	
		Industrial practice III	PD/CC	8	10	Dif.offset	
		Pre-graduate practice	PD/ BD	8	2	Dif.offset	
M.14	Final certification	Final certification	ATT	8	8	FC	8
							240