



**Institute of Automation and Information Technology  
Department “Robotics and Engineering Tools of Automation”**

**EDUCATIONAL PROGRAM  
7M07106- Biomedical Engineering**

Code and classification of the field of education:

**7M07** Engineering, manufacturing and construction industries

Code and classification of training directions:

**7M071 Engineering and engineering trades**

Group of educational programs:

**M102 Robotics and mechatronics**

Level based on NQF: **7**

Level based on IQF: **7**

Study period: **2 year**

Amount of credits: **120**

**Almaty 2024**

Educational program 7M07106- Biomedical Engineering was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes #3 dated 27.10.2022

was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council

Minutes #2 dated 21.10.2022

Educational program 7M07106- Biomedical Engineering was developed by Academic committee based on direction 7M071 «Engineering and engineering trades»

| Full name                                 | Academic degree/<br>academic title              | Position                          | Workplace                                                                           | Signature                                                                             |
|-------------------------------------------|-------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Chairperson of Academic Committee:</b> |                                                 |                                   |                                                                                     |                                                                                       |
| Baktybaev Murat Kyrgyzbaevich             | Candidate of Physical and Mathematical Sciences | Associate Professor               | Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU |   |
| <b>Teaching staff:</b>                    |                                                 |                                   |                                                                                     |                                                                                       |
| Ozhikenov Kassymbek Adilbekovich          | Candidate of Technical Sciences                 | Professor, Head of the Department | Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU |  |
| <b>Employers:</b>                         |                                                 |                                   |                                                                                     |                                                                                       |
| Dzhumagulov Arystanbek Kuyzembraevich     | -                                               | General Director                  | LLP «MEDREMZAVOD HOLDING»                                                           |  |
| Akzhanov Janat Koishibaevich              | -                                               | Director                          | LLP «SAIMAN» Corporation»                                                           |                                                                                       |
| <b>Students</b>                           |                                                 |                                   |                                                                                     |                                                                                       |
| Shylmyrza Usen Jumanuly                   | -                                               | 1st year Master's student         | Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU |  |

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### **List of abbreviations and designations**

EP - Educational program

BD - basic disciplines

PD - profile disciplines

ECTS - European Credit Transfer and Accumulation System

USEC - Universal, social and ethical competencies

S&MC - Special and managerial competencies

PC - Professional competence

EO - educational outcomes

FA - Final attestation

## 1. Description of educational program

Training of specialists in the field of medical and environmental equipment and technologies, the creation and maintenance of tools for diagnosis, treatment, rehabilitation and prevention of human diseases and development of software for solving problems of medical and biological practice.

Master's degree in the field of training "Biomedical Engineering" should be prepared to solve professional tasks in accordance with the profile of the master's program and the types of professional activities:

*research activities:*

- development of programs for scientific research and technical development, preparation of individual tasks for performers;

- collection, processing and systematization of scientific and technical information on the topic of planned research, selection of methods and tools for solving formulated tasks, preparation of tasks for performers;

- mathematical modeling of research technologies for biological objects and biotechnical systems for various purposes using standard software tools;

- development of physical, phenomenological, mathematical and information-structural models of biological objects and processes, assessment of their adequacy, determination of a set of independent indicators that characterize the studied biological object and process;

- organization and participation in conducting biomedical, environmental and ergonomic experiments, collection, processing, systematization and analysis of research results;

- preparation of scientific and technical reports in accordance with the requirements of regulatory documents, preparation of reviews and preparation of publications based on the results of conducted biomedical and environmental studies;

- analysis of patent materials and preparation of applications for inventions and industrial designs;

*design and development activities:*

- analysis of the state of scientific and technical problems by selecting, studying and analyzing literary and patent sources in the field of biotechnical systems and technologies;

- determination of the purpose, setting of design tasks, preparation of technical specifications for the performance of design works in the field of biotechnical systems and technologies;

- design of devices, devices, systems and complexes for biomedical and environmental purposes taking into account the specified requirements;

- development of design documentation in accordance with methodological and regulatory requirements.

*organizational and managerial activities:*

- development of organizational and technical documentation (work schedules, instructions, plans and estimates) and established reporting on approved forms;

- organization of work of small groups of performers involved in research, design and experimental research;

- control over the implementation of measures to prevent industrial injuries, occupational diseases, and prevent environmental violations in the process of research and operation of biological medical systems;

*design and technological activities:*

- development of technical specifications for the design of technological processes and production schemes for biomedical and environmental equipment using automated systems of technological pre-production;

- design of technological processes for the production of biomedical and environmental equipment using automated systems of technological pre-production;

- development of technological documentation for designed devices, devices, systems and complexes for biotechnical, medical and environmental purposes;

- ensuring the manufacturability of products and manufacturing processes, assessing the economic efficiency of manufacturing processes for biomedical and environmental equipment, as well as biotechnical systems in other areas;

- author's support of the developed devices, devices, systems and complexes at the design and production stages;

*installation and commissioning activities:*

- participation in verification, adjustment, adjustment, evaluation of equipment condition and configuration of biomedical systems for various purposes, including both technical means and software control systems;

- participation in interfacing software and hardware complexes with technical objects as part of biomedical systems, in conducting tests and commissioning prototypes of such systems;

*service and maintenance activities:*

- participation in verification, adjustment, adjustment and assessment of the state of biomedical systems for various purposes, as well as their individual subsystems, in the setting up of control hardware and software complexes;

- preventive control of technical condition and functional diagnostics of biomedical systems for various purposes, as well as their individual subsystems;

- preparation of operating instructions for biomedical systems and their hardware and software, development of routine testing programs;

preparation of applications for equipment and components, preparation of technical documentation for equipment repair;

The objects of professional activity of the graduate are:

- biomedical engineering, including information-sensory, Executive and control modules, their mathematical, algorithmic and software, methods and means of their design, modeling, experimental research and design;

- theoretical and experimental studies, analysis of signals, analytical relation for the optimum processing of multidimensional signals, mathematical foundations of pattern recognition, processing, identification and synthesis of speech signals, problem-oriented software systems in biomedical practice, the kinds of provisions for biomedical research, principle that constructs the problem-oriented system, message processing of diagnostic information in real time, complex for

the collection, analysis, processing and storage of biomedical information; data and knowledge bases, systems of forecasting and decision-making software systems, health-technical support of medical institutions.

The term of study in the master's program is determined by the volume of academic credits mastered. When the established amount of academic credits is mastered and the expected learning outcomes for obtaining a master's degree are achieved, the master's degree program is considered fully mastered. In the scientific and pedagogical master's program, at least 120 academic credits are awarded for the entire period of study, including all types of educational and scientific activities of the master's student.

Planning of the content of education, the way of organizing and conducting the educational process is carried out by the University and scientific organization independently on the basis of credit technology of training.

The master's program in scientific and pedagogical direction implements educational programs of postgraduate education for the training of scientific and scientific and pedagogical personnel for Universities and scientific organizations with in-depth scientific and pedagogical and research training.

The content of the master's degree EP consists of:

- 1) theoretical training, including the study of cycles of basic and profile disciplines;
- 2) practical training of undergraduates: various types of internships, scientific or professional internships;
- 3) research work, including the execution of a master's thesis – - for the scientific and pedagogical master's program
- 4) final certification.

Final certification is carried out in the form of writing and defending a master's thesis.

## 2. Purpose and objectives of educational program

**Purpose of EP:** The purpose of the educational program is to train highly qualified, competitive and in-demand specialists in the field of robotics and mechatronics in the labor market, capable of performing design, production, technical, organizational work in professional activities

### **Tasks of EP:**

- development of students through research activities, critical thinking, development of professionally oriented skills and abilities;
- using highly professional experience of teaching undergraduates in various educational environments;
- training a new competitive generation of technical specialists for the labor market;
- developing an environment that welcomes and supports people from different cultures, and creating an atmosphere of striving for knowledge, academic integration and intellectual motivation;
- conducting research, conducting educational activities based on world best practices, and developing their own brand of training specialists;
- development of cooperation "University-industry" to meet the requirements of the labor market for technical specialists, to improve the quality of educational programs for training specialists for the economy and business sector;
- development of additional educational and training programs using multimedia, new teaching technologies for organizing learning based on the principle of lifelong learning;
- establishing partnerships with other universities and organizations to improve the quality of education, to support technical and cultural ties.

### **Competencies for completing training**

| <b>Universal, social and ethical competencies (USEC)</b> |                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U-1                                                      | Ability to communicate orally and in writing in the state, Russian and foreign languages to solve problems of interpersonal and intercultural interaction                                                                                                         |
| U-2                                                      | The ability to assess the surrounding reality based on worldview positions formed by knowledge of the basics of philosophy, which provide scientific understanding and study of the natural and social world by methods of scientific and philosophical knowledge |
| U-3                                                      | Develop an environment that welcomes and supports people from different cultures, and create an atmosphere of striving for knowledge, academic integration, and intellectual motivation                                                                           |
| U-4                                                      | Have the skills of social design and methods of forming and maintaining the socio-psychological climate in the organization                                                                                                                                       |
| U-5                                                      | Ability to critically use the methods of modern science in practice                                                                                                                                                                                               |
| U-6                                                      | Awareness of the need and ability to learn and improve their skills independently throughout their working life                                                                                                                                                   |
| <b>Special and managerial competencies (S&amp;MC)</b>    |                                                                                                                                                                                                                                                                   |
| S-1                                                      | Independently manage and control the processes of work and training activities within the framework of the strategy, policy and goals of the organization, discuss problems, argue conclusions and correctly operate with information                             |

|                                       |                                                                                                                                                                                                          |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S-2                                   | Organize the activities of the production team, make organizational and managerial decisions in the context of different opinions and evaluate the consequences of decisions                             |
| S-3                                   | Organize work in the division to improve, modernize, and unify manufactured biomedical products                                                                                                          |
| S-4                                   | Readiness to lead and participate in the preparation of a feasibility study for projects to create biomedical systems, their subsystems and individual modules                                           |
| S-5                                   | Ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities                                                                                     |
| <b>Professional competencies (PC)</b> |                                                                                                                                                                                                          |
| PC-1                                  | Ability to analyze literature data and, based on the analysis, be able to identify and experimentally implement possible ways to improve biomedical systems                                              |
| PC-2                                  | Ability to conduct professional written and oral communication with all stakeholders in the field of biomedical engineering                                                                              |
| PC-3                                  | The ability to demonstrate a sustained interest in self-study and training of both wards and colleagues, to guide and advise them throughout the entire period of professional activity                  |
| PC-4                                  | Ability to demonstrate a high level of professional activity while solving industrial and / or scientific tasks, observing all the principles of legal and ethical standards                             |
| PC-5                                  | Ability to conduct independent research in biomedical engineering and modernize existing biomedical systems, introduce new methods of digital signal processing with elements of artificial intelligence |
| PC-6                                  | Ability to design modern and reliable blocks and devices, intelligently controlled Executive, information-sensor and navigation modules of biomedical devices and devices                                |
| PC-7                                  | Ability to apply modern software products and the latest technologies to solve and manage interdisciplinary engineering problems in various fields of science and technology                             |
| PC-8                                  | The ability to create adaptive and robust control systems of biotechnical objects                                                                                                                        |
| PC-9                                  | Ability to implement scientific results in the production of biomedical products                                                                                                                         |

### **3. Requirements for evaluating the educational program learning outcomes**

**EO1** - Apply methods and techniques of managing a medical-technical enterprise, organize and carry out work on the purchase and equipping of medical and preventive institutions with modern medical equipment, their operation, installation and commissioning. Develop a marketing package.

**EO2** – Demonstrate professional written and oral communication skills, as well as critical thinking and interdisciplinary problem solving skills.

**EO3** – Organize the activities of the team, make organizational and managerial decisions in the context of different opinions and assess the consequences of the decisions taken.

**EO4** – Apply modern technical means, software products for information management and processing, and the latest technologies to solve problems in the field of biomedical engineering.

**EO5** – Design modern and reliable blocks and devices, intelligently controlled executive, information-sensor and navigation modules of biomedical devices and devices and carry out comprehensive research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the field of history and philosophy of science.

**EO6** – Formulate innovative tasks in the field of biomedical engineering and apply project management methods for their implementation, evaluate the quality of the project management system, analyze the effectiveness of business processes, use software products to perform project management tasks.

**EO7** – Demonstrate a steady interest in self-learning and learning of both mentees and colleagues, guide and advise them throughout the entire period of professional activity.

## 4. Passport of educational program

### 4.1. General information

| №  | Field name                                        | Comments                                                                                                                                                                                                                                                                                                           |
|----|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Code and classification of the field of education | 7M07 Manufacturing and processing industries                                                                                                                                                                                                                                                                       |
| 2  | Code and classification of training directions    | 7M071 Engineering and engineering trades                                                                                                                                                                                                                                                                           |
| 3  | Educational program group                         | M102 Robotics and mechatronics                                                                                                                                                                                                                                                                                     |
| 4  | Educational program name                          | 7M07106 Biomedical Engineering                                                                                                                                                                                                                                                                                     |
| 5  | Short description of educational program          | Training of specialists in the field of medical and environmental equipment and technologies, the creation and maintenance of tools for diagnosis, treatment, rehabilitation and prevention of human diseases and development of software for solving problems of medical and biological practice.                 |
| 6  | Purpose of EP                                     | The purpose of the educational program is to train highly qualified, competitive and in-demand specialists in the field of biomedical engineering in the labor market, capable of performing scientific, pedagogical, industrial, technical and organizational work in professional activities.                    |
| 7  | Type of EP                                        | New                                                                                                                                                                                                                                                                                                                |
| 8  | The level based on NQF                            | 7                                                                                                                                                                                                                                                                                                                  |
| 9  | The level based on IQF                            | 7                                                                                                                                                                                                                                                                                                                  |
| 10 | Distinctive features of EP                        | -                                                                                                                                                                                                                                                                                                                  |
| 11 | List of competencies of educational program       | In the field of research methodology; in the field of scientific and scientific-pedagogical activity in higher educational institutions; in matters of modern educational technologies; in the implementation of scientific projects and research in the professional field; in the field of information analysis. |
| 12 | Learning outcomes of educational program          | EO1-EO07                                                                                                                                                                                                                                                                                                           |
| 13 | Education form                                    | full-time                                                                                                                                                                                                                                                                                                          |
| 14 | Period of training                                | 2 year                                                                                                                                                                                                                                                                                                             |
| 15 | Amount of credits                                 | 120                                                                                                                                                                                                                                                                                                                |
| 16 | Languages of instruction                          | russian, kazakh                                                                                                                                                                                                                                                                                                    |
| 17 | Academic degree awarded                           | Master of Technical Sciences/Master of Engineering and Technology in the educational program « 7M07106 Biomedical Engineering»                                                                                                                                                                                     |
| 18 | Developer(s) and authors                          | Ozhikenov K.A.,<br>Tasbolatova L.T.                                                                                                                                                                                                                                                                                |

## 4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

| №                          | Discipline name                   | Short description of discipline                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Amount of credits | Generated learning outcomes (codes) |     |     |     |     |     |     |
|----------------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------|-----|-----|-----|-----|-----|-----|
|                            |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   | EO1                                 | EO2 | EO3 | EO4 | EO5 | EO6 | EO7 |
| Cycle of basic disciplines |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                                     |     |     |     |     |     |     |
| University component       |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |                                     |     |     |     |     |     |     |
| 1.                         | Foreign language (professional)   | The course is designed for undergraduates of technical specialties to improve and develop foreign language communication skills in professional and academic fields. The course introduces students to the general principles of professional and academic intercultural oral and written communication using modern pedagogical technologies.public discussions; interpret and present the results of scientific research in a foreign language.                                                    | 3                 |                                     | v   |     |     |     |     |     |
| 2.                         | Psychology of management          | The discipline studies the modern role and content of psychological aspects in managerial activity. The improvement of the psychological literacy of the student in the process of implementing professional activities is considered. Self-improvement in the field of psychology and studying the composition and structure of management activities, both at the local level and abroad. The psychological feature of modern managers is considered.                                              | 3                 |                                     |     | v   |     |     |     |     |
| 3.                         | History and philosophy of science | The subject of philosophy of science, dynamics of science, specifics of science, science and pre-science, antiquity and the formation of theoretical science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.              | 3                 |                                     |     |     |     | v   |     |     |
| 4.                         | Higher school pedagogy            | Undergraduates will master the methodological and theoretical foundations of higher school pedagogy, plan and organize the processes of teaching and upbringing, master the communicative technologies of subject-subject interaction between a teacher and a master in the educational process of a university.                                                                                                                                                                                     | 3                 |                                     |     |     |     |     |     | v   |
| 5.                         | Pedagogical practice              | Knowledge of the history of the development of general psychological ideas modern methods of systematic organization of cognitive processes theories and problems. General psychology analysis and comparison of the results of theoretical and Applied Research in the field of knowledge of technical disciplines; application of methods and techniques; independent use in the context of scientific research development and application of ideas; processes and analysis of existing phenomena |                   |                                     |     |     |     |     |     |     |

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|-----------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--|--|--|---|---|---|--|--|
|                                                                 |                                                                         | critical thinking of concepts, theories and approaches analysis from a perspective. Research activities mastering the skills of standard scientific tasks educational and pedagogical credit training methods of teaching professional disciplines                                                                                                                                                                                                                                                                                                                                            |   |  |  |  |   |   |   |  |  |
| <b>Cycle of basic disciplines</b><br><b>Component of choice</b> |                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |  |  |  |   |   |   |  |  |
| 6.                                                              | Biotechnical systems and technologies                                   | The purpose of studying the discipline is to study methods and techniques of analysis and creation of biotechnical systems and technologies. The processes of interaction of biological and technical systems are considered in detail. To show the possibility of applying biotechnical systems and technologies in various fields of biology and medicine. The features of displaying information about the state of the body and the parameters of impacts in the composition of biotechnical systems, the main modern trends in the development of biotechnical technologies are studied. | 5 |  |  |  |   | v |   |  |  |
| 7.                                                              | Intelligent information management and processing systems               | The discipline is aimed at studying the theoretical foundations and practical mastering of working with neural networks, genetic algorithms and expert systems. Formation of practical skills in the use of intelligent systems for management. Understanding the place of intelligent methods among all information technologies. The concept of basic intelligent technologies, their use in computer control systems and application for solving applied problems.                                                                                                                         | 5 |  |  |  |   | v | v |  |  |
| 8.                                                              | Application of methods of technical creativity in innovative activities | The purpose of studying the discipline is to master the basics of practical application of methods of technical creativity in innovation. The basic knowledge and skills of applying the methods of technical creativity in innovation are offered. After studying the course, a master's student must demonstrate the ability to analyze, synthesize and design methods of technical creativity in innovation.                                                                                                                                                                               | 5 |  |  |  |   | v |   |  |  |
| 9.                                                              | Methods for solving inventive tasks                                     | Purpose: the development of the discipline is the development of skills to use tools and methods for solving inventive tasks in the search for solutions to practical and professional problems. Content: introduction to the phenomenon of inventive problem solving and its modern architectonics. Characterization of the levels of creative tasks and the development of key concepts. The concept of the functional nature of problem situations (how they are "split" into inventive and non-inventive tasks). Description of a technical object based on a systematic approach.        | 5 |  |  |  | v |   |   |  |  |
| 10.                                                             | Intellectual property and research                                      | Purpose: the goal is to train specialists who can effectively manage rights to the results of intellectual activity in the field of science, as well as ensure their legal protection and commercialization. Contents: analysis of legal protection of research and development results, methods of commercialization of scientific inventions, ethical and legal aspects of                                                                                                                                                                                                                  | 5 |  |  |  |   |   | v |  |  |

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|--------------------------------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|--|---|---|--|---|---|--|
|                                                              |                                                                       | scientific activity in the context of IP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |  |   |   |  |   |   |  |
| 11.                                                          | Mathematical statistics and probability theory in biomedical research | Purpose: The purpose of the discipline is to study the patterns of random phenomena and their properties, and use them to analyze statistical data. Content: Events. Probability. General properties of probability. The classical definition of probability. Geometric definition of probability. Mathematical expectation. The variance. Covariance. Correlation coefficient practical lesson Mathematical expectation. The variance. Covariance. Correlation coefficient Limit theorems lecture lesson The Law of large numbers. The central limit theorem.                                                    | 5 |   |  |   | v |  | v |   |  |
| 12.                                                          | Modern methods of processing biomedical signals and images            | The purpose of studying the discipline is to form and deepen knowledge about the methods of processing biomedical signals and data. Formation of knowledge about signal processing methods of electrocardiography, high-resolution electrocardiography, rheography, sphygmography, phonocardiography, electroencephalography, electromyography. Formation of knowledge of practical use and implementation of theoretical foundations of automated biomedical systems                                                                                                                                             | 5 |   |  |   | v |  |   |   |  |
| 13.                                                          | Sustainable development strategies                                    | The goal is to develop deep knowledge and competencies in the development and implementation of sustainable development strategies at various levels. The content covers a wide range of topics, ranging from global environmental challenges such as climate change, biodiversity loss and natural resource depletion, to socio-economic aspects including inequality, health and education.                                                                                                                                                                                                                     | 5 | v |  | v |   |  |   | v |  |
| <b>Cycle of profile disciplines<br/>University component</b> |                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |  |   |   |  |   |   |  |
| 14.                                                          | Computer technologies in biomedical research                          | The purpose of studying the discipline is to form the necessary knowledge about technical and software tools for biomedical research, about the creation of algorithms for processing biosignals, ideas about methods and technologies for processing physical information received from a biological object, about computer systems as a tool for working with information, about methods for automating the creation and maintenance of software.                                                                                                                                                               | 5 |   |  |   | v |  |   |   |  |
| 15.                                                          | Research practice                                                     | Formation of professional skills and abilities necessary for the successful implementation of research activities, mastering Research Technology; direct practical activity of undergraduates in order to master the professional qualities of a future specialist; organization of interaction and communication of undergraduates specialists of their future profession for professional adaptation, development of a creative and research approach to future professional activity in undergraduates, mastering the skills of analyzing the results of their labor, formation of the need for self-education |   |   |  |   |   |  |   |   |  |
| <b>Cycle of profile disciplines</b>                          |                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |   |  |   |   |  |   |   |  |

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| Component of choice |                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |  |  |  |  |   |   |   |
|---------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--|--|--|--|---|---|---|
| 16.                 | Control in biotechnical and medical systems                  | The purpose of studying the discipline is to study the theory and methods of automatic and automated control used in the creation of biotechnical systems for various purposes and automated health management systems. Forms knowledge, skills, skills and competencies on control systems of biotechnical systems; beliefs about the need for the development of automatic biotechnical systems to ensure human life; the use of information tools necessary for future professional activity.                                                                                          | 5 |  |  |  |  | v | v |   |
| 17.                 | Intellectual management in conditions of uncertainty         | The discipline "Intellectual management in conditions of uncertainty" is aimed at studying the problems of managing continuous dynamic objects under uncertainty. The tools of sensitivity theory, interval model representations, generalized modal control, Lyapunov function method and adaptive control are studied. Designing control laws that deliver robustness to systems in the sense of the main indicators of the quality of their functioning. Non-adaptive and adaptive management methods.                                                                                 | 5 |  |  |  |  |   | v |   |
| 18.                 | Biomedical measuring information systems                     | The purpose of studying the discipline is to gain new knowledge through the development of fundamental and applied scientific research in the field of biomedical engineering; preparation for research activities, the objects of which are devices, systems and complexes of biomedical purposes, methods and technologies for performing medical, biological, environmental research; automated systems for processing biomedical information; biotechnical control systems.                                                                                                           | 5 |  |  |  |  | v | v |   |
| 19.                 | Technical means of information-measuring systems             | The purpose of studying the discipline is the formation of students' knowledge in the field of information and measurement systems: components, algorithms, structures, characteristics, varieties and purposes of modern information and measurement systems and their parts; features of the use of computers and computer technology in information and measurement systems; organization of human interaction and technology in information and measurement systems; metrological providing systems; sources, types and performance indicators of information and measurement systems | 5 |  |  |  |  | v |   |   |
| 20.                 | Project Management                                           | The discipline studies the components of project management based on modern behavioral models of project-oriented business development management. The program is based on the international standards PMI PMBOK, IPMA ICB and the standards of the Republic of Kazakhstan in the field of project management. The features of organizational management of business development through the interaction of strategic, project and operational management are studied.                                                                                                                    | 5 |  |  |  |  |   |   | v |
| 21.                 | Diagnostics and reliability of technical systems and devices | The purpose of studying the discipline is to study methods for assessing the reliability of technical systems at the design stage, to study methods for assessing the reliability of technical systems in operation, to apply                                                                                                                                                                                                                                                                                                                                                             | 5 |  |  |  |  |   | v |   |

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|     |                                                                               | probability theory to predict and prevent equipment failures, to study methods for diagnosing existing equipment. Accordingly, the teaching of the discipline "Diagnostics and reliability of technical systems and devices" is aimed at arming future specialists with knowledge of the basic provisions of the theory of reliability and survivability of technical systems.                                                                                                                                                       |   |  |  |  |   |   |   |  |
| 22. | Verification, safety and reliability of medical equipment                     | The purpose of studying the discipline is the formation of knowledge about the operation and maintenance of medical devices, biotechnical systems and devices in the conditions of biomedical organizations, training in the principles of ensuring safe living conditions in the development, production and operation of biomedical devices, complexes and systems, training in how to apply methods of organizing routine maintenance, verification and certification of medical equipment.                                       | 5 |  |  |  |   | v |   |  |
| 23. | Filtering and detection of biomedical signals                                 | Purpose: The purpose of the discipline is to study methods and algorithms for processing biomedical signals and data used in the creation of biotechnical and medical systems. Contents: Studying the discipline gives undergraduates the basics of engineering and theoretical skills in processing and analyzing biomedical information. The use of computer technologies for filtering and eliminating artifacts, for identifying discrete epochs of a biomedical signal, for classifying images and making diagnostic decisions. | 5 |  |  |  |   | v |   |  |
| 24. | Digital processing of measurement information                                 | The purpose of the discipline is to study the role and significance of digital signal processing in the reception and transmission of information, the features and advantages of digital representation of signals, the study of digital transformation algorithms, the implementation of digital processing in telecommunications, information-measuring and radiophysical systems and its application in various fields of science, technology and production.                                                                    | 5 |  |  |  | v |   |   |  |
| 25. | Fundamentals of marketing and management in medical and technical enterprises | The purpose of studying the discipline is the formation of knowledge in the field of operation and maintenance of the latest medical equipment and the specifics of medical devices as a special type of industrial goods, as well as the acquisition of practical teamwork skills, problem analysis and the development of management solutions. Study of the basic concepts and categories, as well as trends in the development of management and marketing at medical and technical enterprises                                  | 5 |  |  |  | v |   |   |  |
| 26. | Medical information systems                                                   | The purpose of studying the discipline is to get acquainted with the principles, methods and means of building medical information systems, medical information resources. The study of ways and means of interaction of medical information systems using modern computer technology and new information technologies. Acquisition of skills in designing, developing, implementing and operating medical information                                                                                                               | 5 |  |  |  |   | v | v |  |

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|     |                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |  |   |  |   |   |  |  |
|-----|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|--|---|--|---|---|--|--|
|     |                                                                   | systems in medical institutions of various profiles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |   |  |   |  |   |   |  |  |
| 27. | Automated design of medical equipment                             | The purpose of studying the discipline is to study the methodology of modern methods of designing medical equipment. After studying, the master's student systematizes, consolidates and deepens the theoretical knowledge and skills acquired, applies this knowledge at the stage of technical design, developing skills for independent work, conducting theoretical and experimental research with the involvement of means and methods of microprocessor technology.                                                                                                                                                                                                | 5 |   |  |   |  |   | v |  |  |
| 28. | Designing microprocessor and microcontroller systems              | The discipline is aimed at forming students' knowledge of the general methodology and specific design methods of the main varieties of modern microprocessor tools, as well as knowledge and skills in the field of architecture, principles of functioning and programming of microprocessor systems. Studies the architecture and functionality of modern microprocessors and microcontrollers; methods and technical means of debugging, diagnostics, modeling and design of microprocessor systems and microcontrollers                                                                                                                                              | 5 |   |  |   |  |   | v |  |  |
| 29. | Quality management of production and service of medical equipment | The purpose of studying the discipline is to study the quality assessment model of the process of repair and maintenance of medical equipment. To identify the signs of quality assessment at enterprises for the repair and maintenance of medical equipment. The study of the quality management system of processes in the industrial, commercial and educational spheres. The product quality management system is a set of management bodies and management facilities, measures, methods and means aimed at establishing, ensuring and maintaining a high level of product quality.                                                                                | 5 | v |  |   |  |   |   |  |  |
| 30. | Organization and planning of the production of medical equipment  | The purpose of studying the discipline is to study in the interrelation of the most important issues and factors of the science of the organization of the production of medical equipment, ensuring the effective functioning of an industrial enterprise – the primary link of the material production of medical equipment. The principles of the organization of production processes of medical equipment are studied. Indicators of the organization of the production process. The concept of the organizational type of production and its defining features of medical equipment. Organization of research and development work. Planning of technical training | 5 | v |  | v |  |   |   |  |  |
| 31. | Artificial intelligence in medicine                               | The purpose of studying the discipline is to study the essence and principles of biomedical information processing. Intelligent signal processing methods in biomedicine. Using fuzzy logic theory, wavelet analysis, fractal theory, expert approach and artificial neural network theory to solve biomedical signal processing problems. Definition and classification of biomedical images. Development and operation of medical information systems. Modern methods of processing biomedical images.                                                                                                                                                                 | 5 |   |  |   |  | v |   |  |  |

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|     |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |  |  |  |  |   |   |   |  |
|-----|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--|--|--|--|---|---|---|--|
| 32. | Intelligent control technology  | Studying the theoretical foundations of artificial intelligence, neural network technologies of intelligent systems, technologies for constructing control systems with fuzzy logic, rules of fuzzy logic, technologies for creating a knowledge base, expert control systems, adaptive control systems, theoretical problems and techniques of intelligent systems, etc. These knowledge are necessary for further understanding of the principles of construction of robotic systems                                                                                                                                                                     | 5 |  |  |  |  | ✓ | ✓ |   |  |
| 33. | Planning an experiment          | Purpose: to prepare future specialists for research and organizational and managerial activities and processing of their results. Contents: general questions of the theory of experiment planning. An experiment as an object of research. Methods of the theory of experiment planning. The logical foundations. Statistical processing of measurement results. Analysis of measurement results. Fundamentals of experiment planning. A complete and fractional factorial experiment. Verification of the adequacy of the model obtained from experimental data. Computer methods of statistical processing of the results of an engineering experiment. | 4 |  |  |  |  |   | ✓ | ✓ |  |
| 34. | Statistical methods in research | Purpose: formation of logical and algorithmic thinking of students, which allows them to apply statistical methods in research. Content: The discipline is aimed at studying the basic methods of modeling processes and systems in solving problems of processing and interpretation of experimental data and problems of system engineering and circuit design, the formation of logical and algorithmic thinking of students, allowing the use of statistical methods in engineering research.                                                                                                                                                          | 4 |  |  |  |  |   |   | ✓ |  |

of Educational Program on enrollment for 2024-2025 academic year  
Educational program 7M07106 - "Biomedical engineering"  
Group of educational programs M102 - "Robotics and mechatronics"

| Form of study: full-time                             |                                                                               | Duration of study: 2 year |                         |             | Academic degree: Master of Technical Sciences |                               |                 |                                     |            |            |            |
|------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------|-------------------------|-------------|-----------------------------------------------|-------------------------------|-----------------|-------------------------------------|------------|------------|------------|
| Discipline code                                      | Name of disciplines                                                           | Cycle                     | Total amount in credits | Total hours | Classroom amount lec/lab/pr                   | SIS (including TSIS) in hours | Form of control | Allocation of face-to-face training |            |            |            |
|                                                      |                                                                               |                           |                         |             |                                               |                               |                 | 1 course                            |            | 2 course   |            |
|                                                      |                                                                               |                           |                         |             |                                               |                               |                 | 1 semester                          | 2 semester | 3 semester | 4 semester |
| M-1. Module of basic training (university component) |                                                                               |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| LNG213                                               | Foreign language (professional)                                               | BD UC                     | 3                       | 90          | 0/0/2                                         | 60                            | E               | 3                                   |            |            |            |
| HUM214                                               | Management Psychology                                                         | BD UC                     | 3                       | 90          | 1/0/1                                         | 60                            | E               | 3                                   |            |            |            |
| HUM212                                               | History and philosophy of science                                             | BD UC                     | 3                       | 90          | 1/0/1                                         | 60                            | E               |                                     | 3          |            |            |
| HUM213                                               | Higher school pedagogy                                                        | BD UC                     | 3                       | 90          | 1/0/1                                         | 60                            | E               |                                     | 3          |            |            |
| optional component                                   |                                                                               |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB266                                               | Biotechnical systems and technologies                                         | BD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB204                                               | Intelligent information management and processing systems                     |                           |                         |             | 2/1/0                                         |                               |                 |                                     |            |            |            |
| ROB262                                               | Application of methods of technical creativity in innovation                  | BD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB292                                               | Methods for solving inventive tasks                                           |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| MNG781                                               | Intellectual property and scientific research                                 |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB293                                               | Mathematical statistics and probability theory in biomedical research         | BD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB219                                               | Modern methods of processing biomedical signals and images                    |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| MNG782                                               | Sustainable development strategies                                            |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| M-2. Module of theoretical foundations of management |                                                                               |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB267                                               | Computer technologies in biomedical research                                  | PD UC                     | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB554                                               | Management in biotechnical and medical systems                                | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB203                                               | Intelligent management in conditions of uncertainty                           |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB261                                               | Biomedical measurement information systems                                    | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               |                                     | 5          |            |            |
| ROB224                                               | Technical means of information and measuring systems                          |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| MNG705                                               | Project management                                                            |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| M-3. Control Design Module (optional component)      |                                                                               |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB277                                               | Diagnostics and reliability of technical systems and devices                  | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB278                                               | Verification, safety and reliability of medical equipment                     |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB298                                               | Filtering and detection of biomedical signals                                 | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB279                                               | Digital processing of measurement information                                 |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB271                                               | Fundamentals of marketing and management at medical and technical enterprises | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               | 5                                   |            |            |            |
| ROB287                                               | Medical information systems                                                   |                           |                         |             |                                               |                               |                 |                                     |            |            |            |
| ROB282                                               | Computer-aided design of medical equipment                                    | PD CCH                    | 5                       | 150         | 2/0/1                                         | 105                           | E               |                                     | 5          |            |            |
| ROB239                                               | Design of microprocessor and microcontroller systems                          |                           |                         |             | 2/1/0                                         |                               |                 |                                     |            |            |            |

|                                          |                                                                                               |         |    |     |       |     |                |    |    |    |    |
|------------------------------------------|-----------------------------------------------------------------------------------------------|---------|----|-----|-------|-----|----------------|----|----|----|----|
| ROB246                                   | Quality management of production and service of medical equipment                             | PD CCH  | 5  | 150 | 2/0/1 | 105 | E              |    |    | 5  |    |
| ROB247                                   | Organization and planning of medical equipment production                                     |         |    |     |       |     |                |    |    |    |    |
| ROB268                                   | Artificial intelligence in medicine                                                           | PD CCH  | 5  | 150 | 2/0/1 | 105 | E              |    |    | 5  |    |
| ROB225                                   | Intelligent control technology                                                                |         |    |     |       |     |                |    |    |    |    |
| ROB710                                   | Planning an experiment                                                                        | PD CCH  | 4  | 120 | 0/0/3 | 75  | course project |    |    |    | 4  |
| ROB711                                   | Statistical methods in research                                                               |         |    |     |       |     |                |    |    |    |    |
| <b>M-4. Practice-oriented module</b>     |                                                                                               |         |    |     |       |     |                |    |    |    |    |
| AAP273                                   | Pedagogical practice                                                                          | BD UC   | 8  |     |       |     |                |    |    | 8  |    |
| AAP256                                   | Research practice                                                                             | PD, CCH | 4  |     |       |     |                |    |    |    | 4  |
| <b>M-5. Experimental research module</b> |                                                                                               |         |    |     |       |     |                |    |    |    |    |
| AAP268                                   | Research work of a master's student, including internship and completion of a master's thesis | RWMS UC | 4  |     |       |     |                | 4  |    |    |    |
| AAP268                                   | Research work of a master's student, including internship and completion of a master's thesis | RWMS UC | 4  |     |       |     |                |    | 4  |    |    |
| AAP251                                   | Research work of a master's student, including internship and completion of a master's thesis | RWMS UC | 2  |     |       |     |                |    |    | 2  |    |
| AAP255                                   | Research work of a master's student, including internship and completion of a master's thesis | RWMS UC | 14 |     |       |     |                |    |    |    | 14 |
| <b>M-6. Module of final attestation</b>  |                                                                                               |         |    |     |       |     |                |    |    |    |    |
| ECA212                                   | Preparation and defense of a master's thesis                                                  | FA      | 8  |     |       |     |                |    |    |    | 8  |
| <b>Total based on UNIVERSITY:</b>        |                                                                                               |         |    |     |       |     |                | 30 | 30 | 30 | 30 |
|                                          |                                                                                               |         |    |     |       |     |                | 60 |    | 60 |    |

| Number of credits for the entire period of study |                                        |                           |                           |           |            |
|--------------------------------------------------|----------------------------------------|---------------------------|---------------------------|-----------|------------|
| Cycle code                                       | Cycles of disciplines                  | Credits                   |                           |           |            |
|                                                  |                                        | university component (UC) | component of choice (CCH) | Total     |            |
| BD                                               | Cycle of basic disciplines             | 20                        | 15                        | 35        |            |
| PD                                               | Cycle of profile disciplines           | 9                         | 44                        | 53        |            |
|                                                  | <b>Total for theoretical training:</b> | <b>0</b>                  | <b>29</b>                 | <b>59</b> | <b>88</b>  |
|                                                  | RWMS                                   |                           |                           | 24        |            |
| FA                                               | Final attestation                      | 8                         |                           | 8         |            |
|                                                  | <b>TOTAL:</b>                          | <b>8</b>                  | <b>29</b>                 | <b>59</b> | <b>120</b> |

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № 12 "22 " april 2024 y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № 6 "19" april 2024 y.

Decision of the Academic Council of the Institute of A&IT. Protocol № 8 from "29" february 2024 y.

Vice-Rector for Academic Affairs

R.K. Uskenbayeva

Acting Directors of the Institute of Automation and Information Technology

Z.B. Kalpeyeva

Head of the Department of Robotics and Automation Equipment

K.A. Ozhikenov

Specialty Council representative from employers

A.K. Dzhumagulov