Satbayev University
A. Burkitbayev Institute of Industrial Automation and Digitalization
The Department of "Robotics and Engineering Tools of Automation"

CURRICULUM PROGRAM

"BIOMEDICAL ENGINEERING"
Doctor Ph.D of the educational program "8D07105- Biomedical Engineering"

on the basis of the vitiated Specialty Classifier: 6D071600 - Instrumentation

1st edition
in accordance with the State Educational Standard of Higher Education 2018

Almaty 2020

The program is drawn up and signed by the parties:

from Satbayev University:

1. Head of the Department of Robotics and Engineering Tools of Automation (R&ETA), Ph.D. K. Ozhikenov

2. Director of the Institute of Industrial Automation and Digitalization, PhD B. Omarbekov

3. Chairman of the Educational and Methodological Group of the Department of "R&ETA", Ph.D, Associate Professor Zh. Ualiyev

From the employer:
Director of LLP "MedRemZavodHolding" A. K. Dzhumagulov
Deputy Director for IIT of LLP "Saiman Corporation" K. I. Baibekov

Approved at the meeting of the Educational and Methodological Council of the Satbayev University, (Protocol #3 of 19.12.2018)

Qualification:
Level 8 of the National Qualifications Framework:
8D07 Engineering (Doctor degree):
8D071 Biomedical Engineering

Professional competencies: 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 use of modern methods and technology of scientific communication in the state and foreign languages; in the field of planning and solving the problem of their own professional and personal development.

Brief description of the program:

1. Objectives

- training of a highly qualified specialist in science, capable of forming his own scientific direction in the future;
- preparation of scientific and pedagogical personnel for continuous self-improvement and self-development, mastering new knowledge, skills and abilities in innovative areas of biomedical engineering development;
- preparation of doctoral students for a successful career in the field of biomedical engineering, private, public and public organizations, educational institutions, through teaching disciplines that will provide the profiling knowledge, tools, skills and abilities required in a competitive environment;
- training of scientific and pedagogical personnel, based on the diversity and dynamism of the catalog of elective disciplines of the curriculum, with a predominance of practical skills in competencies, capable of performing professional functions within one or more types of activities based on the final learning outcomes, taking into account the specifics of these types of activities, market requirements for organizational, managerial, professional competencies;
- training of scientific and pedagogical personnel as a competitive specialist in the field of biomedical engineering that meets international standards and allows Kazakhstan to integrate into the global educational space;

2. Types of labor activity

- design and engineering;
- production and technological;
- scientific and research;
- organizational and managerial;
- scientific and pedagogical.

A doctoral student in the direction of training "Biomedical Engineering" should be prepared to solve professional problems in accordance with the profile direction of the doctoral program and types of professional activities:

design and engineering activities:

- analysis of the state of a scientific and technical problem and the definition of goals and objectives for the design of biomedical systems based on the study of world experience:
- making decisions based on the results of calculations for projects and the results of a technical, economic and functional cost analysis of the effectiveness of the designed biomedical systems;

production and technological activities:

- development of methods for conducting theoretical and experimental research on the analysis, synthesis and optimization of the characteristics of materials used in the field of biomedical engineering;

- solving economic and organizational problems of technological preparation of production of biomedical systems and the choice of systems for ensuring the environmental safety of production;

scientific and research activities:

- construction of mathematical models for the analysis and optimization of research objects, the choice of a numerical method for their modeling or the development of a new algorithm for solving the problem;
- development and optimization of field experimental studies of biomedical systems, taking into account the criteria of their reliability;
- preparation of scientific and technical reports, reviews, publications based on the results of research performed;
- application of the results of research activities and the use of rights to objects of intellectual property;

organizational and management activities:

- finding optimal solutions when creating science-intensive products, taking into account the requirements of quality, cost, deadlines, competitiveness, life safety, as well as environmental safety;
- support of a unified information space for planning and enterprise management at all stages of the life cycle of manufactured products;
- development of plans and programs for organizing innovative activities at the enterprise;
- deep knowledge and understanding of fundamental phenomena in their field of science.

scientific and pedagogical activity:

- development of programs of academic disciplines and courses based on the study of pedagogical, scientific, technical and scientific-methodical literature, as well as the results of their own professional activities;
- setting up and modernization of individual laboratory works and workshops in professional disciplines;
- conducting training sessions with students, participating in the organization and management of their practical and research work;
- application and development of new educational technologies, including computer and distance learning systems.

3. Objects of professional activity

- teaching activity in higher educational institutions according to the profile of training;
- research activities in higher educational institutions and scientific organizations according to the profile of training;
- professional activity in the field of biomedical engineering, requiring highly qualified personnel;

- administrative and organizational activities in higher educational institutions and scientific organizations by training profile.

PASSPORT OF THE EDUCATIONAL PROGRAM

1 Volume and content of the program

The educational program for the preparation of a Doctor of Philosophy (PhD) has a scientific and pedagogical focus and involves fundamental educational, methodological and research training and in-depth study of problems and various processes in the relevant areas of science for the system of higher and postgraduate education and the scientific sphere.

The educational program for the preparation of a doctor in the profile assumes fundamental educational, methodological and research training and in-depth study of problems and various processes in the relevant areas of science for the branches of the national industry and economy, the social sphere: education, medicine, law, art, economics, business administration and areas of national security and military affairs.

Educational programs for doctoral studies in terms of vocational training are developed on the basis of studying the experience of foreign universities and research centers that implement accredited training programs for PhD doctors or doctors in the field.

The content of the educational program of specialized doctoral studies is established by the university independently.

The main criterion for the completeness of the educational process for the preparation of doctors of philosophy (PhD) (doctor in the profile) is the mastering of at least 180 academic credits by a doctoral student, including all types of educational and scientific activities.

The term of study in doctoral studies is determined by the amount of acquired academic credits. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a Doctor of Philosophy (PhD) degree or by profile, the doctoral study program is considered fully mastered and completed with the successful defense of a doctoral dissertation prepared in compliance with the existing rules.

Training of personnel in doctoral studies is carried out on the basis of educational programs in two directions:

1) scientific and pedagogical with a training period of at least three years;

2) specialized with a training period of at least three years.

EP content

The educational program for the training of a doctor in the profile consists of cycles of basic (BD) and major disciplines (PD) of disciplines, which include disciplines of the university component (UC) and components of choice (CC), practice, indicating the labor intensity of each academic discipline in academic credits and hours established by the State Compulsory Standards of Higher and Postgraduate Education, approved by order

of the Ministry of Education and Science of the Republic of Kazakhstan №604 dated October 31, 2018.

The BD cycle includes the study of academic disciplines and the passage of professional practice. The PD cycle includes academic disciplines and types of professional practices. The programs of disciplines and modules of the BD and PD cycles are interdisciplinary and multidisciplinary in nature, providing training at the junction of a number of areas of knowledge.

Final certification is carried out in the form of writing and defending a doctoral dissertation.

Objectives of the educational program:

- the direction of its activities to make a contribution to the development of a knowledge-based society by providing educational programs in the system of continuing education;
- development of students through research activities, critical thinking, development of professionally oriented skills and abilities;
- the use of highly professional experience in teaching doctoral students in a variety of 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 pursuit of knowledge, academic integration and intellectual motivation;
- carrying out research work, conducting educational activities based on the best world practice, and developing its own school for training specialists;
- development of cooperation "university-industry" to meet the labor market requirements for technical specialists, to improve the quality of educational programs for training specialists for the national industry and the economy and business sector;
- development of additional educational and training programs using multimedia and new teaching technologies for organizing learning based on the principle of lifelong learning;
- establishing partnerships with other universities, organizations in order to improve the quality of education, to support technical and cultural ties.

2 Requirements for applicants

Persons with a master's degree and work experience of at least 1 (one) year or who have completed a residency are admitted to doctoral studies.

Enrollment in the number of doctoral students is carried out by the admissions committees of universities and scientific organizations based on the results of the entrance exam for the groups of doctoral programs and a certificate confirming proficiency in a foreign language in accordance with common European competencies (standards).

When enrolling in universities, doctoral students independently choose an educational program from the corresponding group of educational programs.

The enrollment of persons for the targeted training of doctors of philosophy (PhD) under the state educational order is carried out on a competitive basis.

The procedure for admitting citizens to doctoral studies is established in accordance with the "Standard rules for admission to training in educational organizations that implement educational programs of postgraduate education."

The formation of a contingent of doctoral students is carried out by placing a state educational order for the training of scientific and pedagogical personnel, as well as by paying for training at the expense of citizens' own funds and other sources. The state provides citizens of the Republic of Kazakhstan with the right to receive, on a competitive basis, in accordance with the state educational order, free postgraduate education, if they receive education of this level for the first time.

At the "entrance" the doctoral student must have all the prerequisites necessary for mastering the relevant professional doctoral curriculum. The list of required prerequisites is determined by the higher education institution independently.

In the absence of the necessary prerequisites, the doctoral student is allowed to master them on a paid basis. In this case, doctoral studies begin after the doctoral student has fully mastered the prerequisites.

3 Requirements for completing training and obtaining a diploma

Persons who have mastered the educational program of doctoral studies and defended their doctoral dissertation, with a positive decision of the dissertation councils of universities with a special status or the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, based on the results of the examination, are awarded the degree of Doctor of Philosophy (PhD) or Doctor of Science in profile and issued a state diploma with an attachment (transcript).

Persons who have received a PhD degree, to deepen scientific knowledge, solve scientific and applied problems on a specialized topic, carry out a postdoctoral program or conduct scientific research under the guidance of a leading scientist of the selected university.

3.1 Requirements for key competencies of doctoral graduates:

1) have an idea:

– about the main stages of development and the change of paradigms in the evolution of science;

– on the subject, ideological and methodological specifics of the natural (social, humanitarian, economic) sciences;

– about scientific schools of the relevant branch of knowledge, their theoretical and practical developments;

– on the scientific concepts of world and Kazakh science in the relevant field;

– on the mechanism of implementation of scientific developments in practice;

– about the norms of interaction in the scientific community;

– about the pedagogical and scientific ethics of the scientist-researcher;

2) know and understand:

– modern trends, directions and patterns of development of domestic science in the context of globalization and internationalization;

– methodology of scientific knowledge;

– achievements of world and Kazakh science in the relevant field;

– (to understand and accept) the social responsibility of science and education;

– perfect foreign language for scientific communication and international cooperation;

3) be able to:

– organize, plan and implement the process of scientific research;

– analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions;

– analyze and process information from various sources;

– conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis;

– generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;

– to choose and effectively use modern research methodology;

- to plan and predict their further professional development;

4) have skills:

– critical analysis, assessment and comparison of various scientific theories and ideas;

– analytical and experimental scientific activities;

– planning and forecasting research results;

– oratory and public speaking at international scientific forums, conferences and seminars;

– scientific writing and scientific communication;

– planning, coordination and implementation of scientific research processes;

– a systematic understanding of the field of study and demonstrate the quality and effectiveness of the selected scientific methods;

– participation in scientific events, fundamental scientific domestic and international projects;

– leadership management and team leadership;

– responsible and creative attitude to scientific and scientific-pedagogical activities;

– conducting patent search and experience in transferring scientific information using modern information and innovative technologies;

– protection of intellectual property rights to scientific discoveries and developments;

– free communication in a foreign language;

5) be competent:

– in the field of scientific and scientific-pedagogical activity in conditions of rapid renewal and growth of information flows;

– in carrying out theoretical and experimental scientific research;

– in the formulation and solution of theoretical and applied problems in scientific research;

– in conducting a professional and comprehensive analysis of problems in the relevant area;

– in conducting a professional and comprehensive analysis of problems in the relevant area;

– in matters of interpersonal communication and human resource management;

– in matters of university training of specialists;

– in the examination of scientific projects and research;

– in ensuring constant professional growth.

3.2 Requirements for SDRW of a student under the (PhD) program:

1) compliance with the main problems of the educational program of doctoral studies, on which the doctoral dissertation is being defended;

2) is relevant and contains scientific novelty and practical significance;

3) is based on modern theoretical, methodological and technological achievements of science and practice;

4) is based on modern methods of data processing and interpretation using computer technology;

5) carried out using modern scientific research methods;

6) contains research (methodological, practical) sections on the main protected provisions.

3.3 Requirements for organizing practices:

The practice is carried out with the aim of developing practical skills in scientific, scientific, pedagogical and professional activities.

The educational program of doctoral studies includes:

1) teaching and research practice - for students under the Ph.D. program;

2) industrial practice - for students under the program of specialized doctoral studies.

During the period of pedagogical practice, doctoral students, if necessary, are involved in conducting classes in undergraduate and graduate programs.

The research practice of a doctoral student is carried out with the aim of studying the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as consolidating practical skills, applying modern research methods, processing and interpreting experimental data in the dissertation research.

The industrial practice of a doctoral student is carried out in order to consolidate the theoretical knowledge gained in the training process and improve the professional level. The content of research and industrial practice is determined by the topic of the doctoral dissertation.

4 Working curriculum of the educational program

4.1. The term of study is 3 years

MODULAR CURRICULUM

Education program *8D07105 - Biomedical Engineering*

Form of study: *full* Duration of training: *3 years* Academic degree*: Doctor of Philosophy (PhD)*

The cycle	Code	Name of disciplines	Semester	Acad. credits	lec.	lab.	Tutorial	IWD	Type of Final assessment	Department
Fundamental training module (12 credits)										
Mandatory disciplines										
BD 1.2.1	LNG304	Academic writing	1	6	2	0	1	3	Exam	EL
BD 1.2.2	MET321	Research methods	1	6	2	0	1	3	Exam	MPHETSM
Module of robotic and mechatronic systems (18 credits)										
Elective disciplines										
BD 1.2.3	ROB316	Automated systems for processing biomedical information	1	6	2	0	1	3	Exam	RaETA
BD 1.2.3.1	ROB310	Methods of sensing robotic and mechatronic systems	1	6	2	0	1	3	Exam	RaETA
PS 1.3.1	ROB313	Biomedical Intelligent Systems	1	6	2	0	1	3	Exam	RaETA
PS 1.3.1.1	ROB306	Intelligent control of robotic systems	1	6	2	0	1	3	Exam	RaETA
PS 1.3.2	ROB315	Design of technical means for the removal, processing and analysis of biomedical signals	1	6	2	0	1	3	Exam	RaETA
PS 1.3.2.1	ROB317	To design advanced humanoid robots	1	6	2	0	1	3	Exam	RaETA
Practice-oriented module (20 credits)										
BD 1.2.4	AAP350	Pedagogical practice	2	10	0	0	0		Report	RaETA
PS 2.3.3	AAP349	Research scientific training	3	10	0	0	0		Report	RaETA
Research Module (123 credits)										
DSRW	AAP345	Doctoral student research work, including internships and doctoral dissertations	2	24						
DSRW	AAP345	Doctoral student research work, including internships and doctoral dissertations	3	24					Report	RaETA
DSRW	AAP346	Doctoral student research work, including internships and doctoral dissertations	4	25					Report	RaETA
DSRW	AAP346	Doctoral student research work, including internships and doctoral dissertations	5	25					Report	RaETA
DSRW	AAP346	Doctoral student research work, including internships and doctoral dissertations	6	25					Report	RaETA
Module of final attestation (12 credits)										
FA	ECA303	Writing and defending doctoral dissertation	4	12					Defense of dissertation	RaETA

Total	**185**						

5 Descriptors of the level and scope of knowledge, abilities, skills and competencies

The third level descriptors within the Comprehensive Qualifications Framework of the European Higher Education Area (EC-EHEA) reflect learning outcomes that characterize the student's abilities:

1) demonstrate a systematic understanding of the field of study, mastering the skills and research methods used in this area of biomedical engineering;

2) demonstrate the ability to think, design, implement and adapt an essential research process with a scientific approach;

3) contribute with their own original research to expand the boundaries of the scientific field that deserves publication at the national or international level

4) critically analyze, evaluate and synthesize new and complex ideas;

5) communicate your knowledge and achievements to colleagues, the scientific community and the general public;

6) to promote, in an academic and professional context, the technological, social or cultural development of a knowledge-based society.

6 Competencies at the end of training

Universal, social and ethical competencies (USEC)	
U-1	Have an idea of the pedagogical and scientific ethics of a research scientist
U-2	Have an understanding of the norms of interaction in the scientific community
U-3	to Know and understand the methodology of scientific knowledge
U-4	Ability to critically use the methods of modern science in practical activities
U-5	ggenerate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge
Special and managerial competencies (S&MC)	
S-1	Independently manage and control the processes of labor and educational activities within the framework of the strategy, policy and goals of the organization, discuss problems, argue conclusions and competently 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	ToTo conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis

S-4	Readiness to lead and participate in the preparation of technical and economicfeasibility studies for the creation of biotechnical systems, their subsystems and individual modules
S-5	Ability to critically analyze, present, protect, discuss and disseminate the results of their professional activities
Professional competencies (PC)	
PC-1	Analyze the state of scientific and technical problems and determine the goals and objectives of designing biotechnical systems based on the study of world experience
PC-2	Decision-making based on project calculations and results of technical-economic and functional-cost analysis of the effectiveness of designed biotechnical systems
PC-3	Develop a methodology for conducting theoretical and experimental studies on the analysis, synthesis and optimization of the characteristics of materials used in the field of biomedical engineering
PC-4	Build mathematical models for analyzing and optimizing research objects, choose a numerical method for modeling them, or develop a new algorithm for solving
PC-5	Find optimal solutions for creating high-tech products, taking into account the requirements of quality, cost, deadlines, competitiveability , life safety, and environmental safety
PC-6	Develop curricula of academic disciplines and courses based on the study of pedagogical, scientific, technical and scientific-professional activities in the field of biomedical engineering

Matrix of competencies of the educational program “Biomedical Engineering”

Discipline index	Name of the discipline	Universal, social and ethical					Special and managerial					Professional services					
		U-1	U-2	U-3	U-4	U-5	S-1	S-2	S-3	S-4	S-5	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6
Required component																	
ROB309	Optimization methods and theory	x		x		x	x		x	x	x			x	x	x	x
ROB311	Management in biotechnical systems		x		x			x				x		x	x		x
ROB308	Control systems of mechatronic and robotic complexes				x			x				x	x	x			x
ROB312	Automated systems for processing biomedical information									x			x		x	x	
ROB310	Methods of sensing robotic and mechatronic systems					x			x	x		x		x		x	x
ROB313	Biomedical intelligent systems										x	x			x	x	x
ROB306	Intelligent control of robotic systems										x	x			x	x	x
ROB314	Methods of mathematical processing of biomedical data					x			x	x			x	x		x	
ROB305	Microprocessor technology in mechatronics and robotics										x	x	x			x	x
ROB315	Design of technical means for capturing, processing and analyzing biomedical signals					x		x	x	x		x			x		x
ROB303	Designing mechatronic systems on Matlab/Simulink					x		x	x	x		x		x		x	x
State final certification																	
ECA303	Writing and defending a doctoral dissertation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Additional types of training																	
AAP345 AAP346	The research work of the doctoral student, including internship and her doctoral dissertation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
AAP350	Teaching practice	x					x										x
AAP349	Research practice	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

7 Appendix to the diploma according to the ECTS standard

The application was developed according to the standards of the European Commission, Council of Europe and UNESCO / CEPES. This document is for academic recognition only and is not an official proof of education. Not valid without a university degree. The purpose of completing the European Supplement is to provide sufficient information about the holder of the diploma, the qualification obtained, the level of this qualification, the content of the study program, the results, the functional purpose of the qualification, as well as information about the national education system. The application model that will be used to translate grades uses the European Credit Transfer or Transfer System (ECTS).

The European Diploma Supplement provides an opportunity to continue education at foreign universities, as well as to confirm national higher education for foreign employers. When going abroad for professional recognition, additional legalization of the educational diploma is required. The European Diploma Supplement is completed in English upon individual request and is issued free of charge.

8 Brief description of courses

Optimization methods and theory

CODE – ROB309
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
The purpose of teaching the discipline is to master the methods of creating and researching optimal systems for automatic and automated control of both individual industrial units and technological production processes of any degree of complexity for doctoral students; mastering the static and dynamic modes of operation of automatic systems, the peculiarities of their functioning and the possibility of using them to control objects in any technical environment.
BRIEF DESCRIPTION OF THE COURSE
The training course " Optimization methods and theory" is focused on the formation of doctoral students' understanding of methods for constructing and researching optimal control systems for mechatronic and robotic devices. General optimization concepts. Automatic optimization systems. Extreme regulation systems. Study of the dynamic regime of an extreme system. Foundations of the theory of optimal control. Optimal control systems. Optimality criteria. Automatic control is optimal in terms of speed. Synthesis of the time-optimal control law. Dynamic programming. Optimality principle. Bellman equation. Dynamic programming method for solving the problem of synthesis of an optimal control device. Optimal systems with incomplete information about the controlled object. The problem of synthesizing an optimal control law in terms of accuracy and its solution by the method of dynamic programming. Methods for the development of optimal laws and control systems for electric drives.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of mastering the discipline, students must:
know:
theory and foundations of setting optimal control problems;
be able to:
understand optimal control problems, optimization and optimality criteria;
own:
analytical design of optimal controllers and practical methods for determining the coefficients of stabilizing control.

Management in biotechnical systems

CODE – ROB311
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
Objectives of mastering the discipline: the formation of knowledge, abilities, skills and competencies in management systems for biotechnical systems; the formation of a belief about the need to develop automatic biotechnical systems to ensure human life; use of information tools necessary for future professional activities.
BRIEF DESCRIPTION OF THE COURSE
Course content: Basic concepts of the theory of automatic control. Classification of automatic control systems. Linear automatic control systems. Non-linear automatic control systems. Optimization of the control strategy. Observability and manageability. Quality criteria. Passive and active control in living systems. Biofeedback and biofeedback.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of mastering the discipline "Management in biotechnical systems" students must:
know:
- tasks of a controlled biomedical experiment, solved with the use of modern technical means; principles, technical means and methods of organizing a medical and biological experiment; methods of organizing the collection, processing of biomedical information, control and management of the experiment; hardware and software for automation systems for biomedical research in physiological, biophysical and neurophysiological experiments;
be able to:
- to use the acquired knowledge when organizing a medical experiment using technical means; efficiently organize the processing and presentation of experimental data;
own:
- the skills of using standard devices and programs for automating research in a controlled medical and biological experiment.

Automated systems for processing biomedical information

CODE – ROB
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
Discipline objectives. Development of a system of views on the correct use of existing mathematical methods and algorithms for the analysis of experimental information of different physical nature in biomedical practice.
BRIEF DESCRIPTION OF THE COURSE
Living object as a source of measurement information. Characteristics of biomedical information. Biological signals and their properties. Mathematical models of biosignals. Signal analysis theory. Analytical relationships for optimal processing of multidimensional signals. Digital image processing. Mathematical foundations of pattern recognition. Processing, identification and synthesis of speech signals. Problem-oriented software systems in biomedical practice. Types of medical and biological research support. Problem-oriented languages. Indicators of the quality of the software system. Software for processing diagnostic information in real time. Complexes for collection, analysis, processing and storage of biomedical information; databases and knowledge, forecasting and decision-making systems, software for systems of medical and technical support of medical institutions.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of mastering the discipline, students must:
know:
- ways of presenting experimental information; mathematical models underlying various methods of information processing and analysis; methods and algorithms for assessing the informativeness of parameters describing the studied processes, phenomena and objects; methods and algorithms for ordering information depending on the selected criteria and research objectives;
be able to:
- to assess the statistical properties of experimental data tables; form a set of alphabets describing the studied phenomena; correctly and reasonably choose methods for describing the initial data, as well as methods and algorithms for their analysis, adequate to the objectives of the study;
own:
- practical skills in the automation of processing and analysis of medical and biological data.

Biomedical Intelligent Systems

CODE – ROB313
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
The purpose of studying the discipline is to prepare undergraduates to participate in the design of devices, instruments, systems and complexes using modern intelligent technologies for processing and analyzing signals and data.
The main tasks of studying the discipline are the formation of general ideas and knowledge about models and methods of processing knowledge on objects of design and technological design, about methods and means of processing texts in natural languages, about methods and means of formal representation, storage and processing of knowledge, about methods of automatic formation of logical conclusions, about the methods and means of machine learning, about the hardware for the implementation of advanced computing systems, about the theory and practice of neural networks.
BRIEF DESCRIPTION OF THE COURSE
The central tasks of artificial intelligence. The functional structure of using artificial intelligence systems. Solving problems by the search method in the state space. Problem solving by reduction method. Solving deductive choice problems. Problem solutions using non-monotonic logics, probabilistic logics Representation of knowledge in intelligent systems Features of knowledge. Transition from the Database to the Knowledge Base. Production systems. Components of production systems. Search organization decision strategies. A logical approach. Representation of simple facts in logical systems. Features of planning targeted actions. Estimation of the complexity of the planning problem. Expert systems. End user interface. Knowledge representation in ES. Fuzzy sets and fuzzy logic. Fuzzy algorithms. Fuzzy inference methods. Defuzzification methods. Methods of working with knowledge Systems for acquiring knowledge from experts. Formalization of quality knowledge. Natural language understanding systems Preconditions for the emergence of natural language understanding systems.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of studying the discipline, the student must:
know:
- models and methods of knowledge processing;
- architecture and principles of construction and operation of SMS and knowledge bases;
- basic packages of mathematical signal processing, installation methods and capabilities
- architecture of expert systems

- architectures and principles of implementation of computing systems in key logic - models of neural networks
- learning algorithms for neural networks (NN).

be able to:

- apply technology for solving problems in expert systems;
- apply methods of modeling plausible reasoning;
- implement procedures for searching for new technical solutions based on knowledge bases
- develop components of artificial intelligence systems
- to analyze and justify the choice of hardware and software for artificial intelligence systems
- analyze the element base of the hardware of artificial intelligence systems
- apply neural network technologies for processing design and technological information
- apply neural networks to solve problems of approximation of functions and forecasting of time series.

own:

- methods of developing expert systems
- methods of processing declarative knowledge
- methods for the development of decision-making subsystems for information support systems of the ES life cycle
- methods of synthesis of effective algorithms for learning neural networks
- methods of synthesis of effective NS topologies
- methods of ensuring the stability and quality of the NS work
- experience of working in a team to solve global problems.

Methods of mathematical processing of medical and biological data

CODE – ROB314
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
The purpose of the course is to form a student's system of views on the correct use of existing mathematical methods and algorithms for the analysis of experimental information of various physical nature.
Objectives of studying the discipline: to form a general idea of the content, tasks and methods of scientifically grounded assessments of measurement results in the field of biomedical research. As a result of studying the discipline, the student must master: basic methods of signal processing; features of correlation and spectral analysis of signals; applied aspects of statistical data analysis; methods for analyzing numerical data; research methods for multidimensional data; the main directions and prospects for improving computing systems for data analysis.
BRIEF DESCRIPTION OF THE COURSE
Characteristics and data models. Variable types. Nominal scale. Binary signs. Scale of ranks. Interval scale. Ratio scale Statistical methods of data analysis. Basic statistical indicators of experimental data tables (TED). Preliminary processing. Filling in gaps and removing artifacts in the TED. The main provisions of cluster analysis. Cluster concept. Polyvariety of results. Distances between clusters. Spherical clusters with the same radius. A fixed number of spherical clusters. Dynamic condensation algorithm for a given number of classes. McKean's algorithm. Single link method. Cluster division algorithms. Consistent dichotomization. The shortest open path. Algorithm "CRAB". Using distribution densities. Neural networks in the problems of classification of biomedical data. Fuzzy sets and fuzzy decision-making logic. Generalized Fourier series. Wavelet transform. Rademacher, Walsh, Hadamar, Haar transformations.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of mastering the discipline, the student must:
know:
- basic modern mathematical methods for intelligent processing of biomedical signals and images;
- basic concepts and modern principles of working with biomedical information, as well as have an idea of corporate medical information systems and databases;
be able to:
- solve applied mathematical problems used in intelligent processing of biomedical signals and images;
- to process empirical and experimental biomedical data;

- to apply methods and means of bioinformation technologies to solve problems of intelligent processing of biomedical signals and images;

own:

- mathematical, statistical and quantitative methods for solving problems of intelligent processing of biomedical signals and images;
- software for working with medical information;
- the skills of using professional terminology in the field of modern methods of intelligent processing of biomedical data.

Design of technical means for pickup, processing and analysis of biomedical signals

CODE – ROB314
CREDIT – 5
PRECONDITION – no

PURPOSE AND OBJECTIVES OF THE COURSE
Aims and objectives of the discipline: acquaintance of students with current problems and promising directions in the design of technical means for the acquisition, processing and analysis of biomedical signals using modern computer-aided design (CAD) methods, the acquisition of practical skills in solving modern design problems.
BRIEF DESCRIPTION OF THE COURSE
General issues of designing medical diagnostic equipment (MDA). Stages of MDA development. Operating conditions and requirements for MDA. Standardization of the development of MDA and the release of design documentation. The concept of ESKD. Design and Schematic Documentation CAD Basics MDA. Methods and algorithms for layout, placement and tracing of printed circuit boards in the design of MDA. Design and production technology of electronic components. Design and calculation of printed circuit boards. Providing protection of MDA from external and parasitic influences.
KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE COURSE
As a result of mastering the discipline, the student must:
know:
- stages of the design and manufacture of medical equipment;
- basic design principles;
- the composition of the design documentation;
- requirements for the design of the product, ensuring reliability, noise immunity, thermal conditions and protection against external influences;
- basic concepts of CAD, standard software packages used in design; indicators of manufacturability of the structure; typical and special technological processes of instrument making;
- the basics of building and equipping technological processes of manufacturing, assembly, control and testing of medical equipment;
methods of mechanization and automation of production processes, ways of standardization and unification of technological processes;
- composition of technological documentation.
be able to:
- choose the materials and shape of the product and its elements;
- to develop technological processes for their manufacture, assembly and electrical installation;
- to provide noise immunity, normal thermal conditions and the ability
structures to resist external influences;

- calculate the main design and technological characteristics of the product;
- use automated systems for design and technological design;
- to develop design and technological documentation.

own:

- skills in the development of technological processes for the manufacture, assembly and electrical installation of medical equipment;
- the main methods for calculating the design and technological characteristics of the product;
- basic CAD methods.

Writing and defending a doctoral dissertation

CODE – ECA302
CREDIT – 12
PRECONDITION-no

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of the doctoral dissertation is to assess the scientific-theoretical and research-analytical level of the doctoral student, the former professional and managerial competencies, the readiness to independently perform professional tasks and the compliance of its preparation with the requirements of the professional standard and the educational program of doctoral studies.

BRIEF DESCRIPTION OF THE COURSE

Doctoral dissertation is a scientific work of a doctoral student, which is an independent study, in which theoretical provisions are developed, the totality of which can be qualified as a new scientific achievement, or a scientific problem is solved, or scientifically grounded technical, economic or technological solutions are set forth, the implementation of which makes a significant contribution to development the country's economy.

A doctoral dissertation is the result of the research / experimental research work of a doctoral student, carried out during the entire period of study of a doctoral student.

The defense of a doctoral dissertation is the final stage of the master's preparation. A master's thesis must meet the following requirements:

- The topic of the dissertation should be related to priority areas of development of science and / or government programs or programs of fundamental or applied research.
- The content of the thesis, the goals and objectives, the scientific results obtained must strictly correspond to the topic of the thesis.
- The dissertation is carried out in compliance with the principles of independence, internal unity, scientific novelty, reliability and practical value.

Content

РЕЦЕНЗИЯ

на образовательную программу
«8D07105 Биомедицинская инженерия»

Содержание образовательной программы докторантуры разработано на основе принципов непрерывности и преемственности с предыдущим уровнем образования - магистратура. Все дисциплины являются логическим продолжением дисциплин магистратуры, их содержание носит более углубленный характер.

Структура образовательной программы докторантуры содержит две равнозначные компоненты: образовательную и научную, определяющие содержание образования, и отражает их соотношение, измерение и учет и формируется из различных видов учебной, научно-исследовательской работы докторанта, исследовательской педагогической практики, определяющих содержание образования, отражает их соотношение, измерение и учет.

Продолжительность освоения образовательной программы докторантуры составляет 3 года.

Образовательная программа докторантов ориентирована на реализацию компетентностного подхода в обучении. В структуре образовательная программа учитывается наличие обязательных компонентов типового учебного плана государственного общеобязательного стандарта образования РК.

Программа обеспечивает изучение и исследование всех видов современных информационно-измерительных систем и комплексов.

Программа обеспечивает докторантам возможность проходить стажировку за рубежом и проводить различные исследовательские работы. Развивает у докторантов способности к пониманию современных достижений в области проблем развития приборостроения.

Директор ТОО «MedrRemZavod Holding» **Джумагулов А.К.**