NATIONAL TECHNICAL UNIVERSITY OF UKRAINE

“IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE”

FACULTY OF BIOMEDICAL ENGINEERING

APPROVED

Department of educational process organization
_____ Anatoliy MELNYCHENKO

«___»_____ 2021 year

F-CATALOG
ELECTIVE ACADEMIC DISCIPLINES OF
THE CYCLE OF PROFESSIONAL TRAINING

for Master's degree students

educational program “Medical engineering”

specialty 163 Biomedical engineering

APPROVED:

Methodological council
Igor Sikorsky KPI
(protocol № 6 from « 25 » 02 2021 year)

Academic council of
the faculty of biomedical engineering
Igor Sikorsky KPI
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CONTENTS

Regulations on the students` right to select academic disciplines 3
F-Catalog – 2021 year 5
Annotations of elective disciplines 7
1 Artificial organs
2 Devices for replacing vital functions of the body
3 Design of biomedical information systems
4 Endo- and exoprosthetics
5 Prosthetic and orthopedic and rehabilitation equipment
6 General and laboratory immunology
7 Biomaterials and biotechnology
8 Physiotherapeutic medical devices
9 Fundamentals of genomics and proteinomics
10 Electronic sensors and biochip
11 Biophotonics and nanoelectronics
12 Medical devices and technologies
13 Systemic physiology
14 Physiology of sensory systems
15 Biological pharmacy

Regulations on the students` right to select academic disciplines

According to the Section X of Article 62 of the Law of Ukraine "On Higher Education" (№ 1556-VII of 01.07.2014), Elective disciplines are the disciplines of the student`s free choice for a certain level of higher education. They are aimed to provide general and special (professional) competencies within the specialty. Elective courses should comprise no less than 25% of the total number of ECTS credits for the level of education.

The catalog contains an annotated list of disciplines offered for selection by graduate students of the second educational and research level of higher education under the curriculum.

The procedure by which the students are able to choose academic disciplines includes the following stages:

– provide the students access to the list of elective disciplines corresponding to the educational components for a particular academic year;
– departments of the faculty provide students with an ability to indicate their choice of appropriate educational components through questionnaires, test forms, etc.
– students are required to choose elective disciplines from the general university catalog via the “Electronic campus” system following the procedure approved by the University (“Regulations on the Individual curriculum of a student of Igor Sikorsky KPI”);
– students are required to choose elective courses from the F-Catalogs of the interdepartmental/departmental catalogs following the procedure approved by the Faculty of Biomedical Engineering by choice means indicated by each department of the faculty;
– student choice of educational components is counted at the departments along with the dean's office to form study groups of chosen disciplines with regards to the normative and/or the minimum number of students in the group. The normative number of students in groups to study the discipline of the cycle of professional training for master students is 5-25 (minimum of 5 students);
– provided that it is impossible to form study groups with the normative or minimum number for studying a certain discipline, students are usually given another round of choice indication within previously formed groups. In some cases, upon a substantiated application and decision of the providing department, it is possible to study the chosen discipline with the help of other forms of education (individual consultations, mixed form of education, etc.). In case the number of students within a group does not meet the minimum, preference is given to a mixed form of education;

– the final decision made by students on the choice of educational components for the next academic year is documented with a written application. The results of the student's choice of academic disciplines are noted in the individual curriculum for the next academic year in the section “Elective disciplines”.

Generalized information on the disciplines chosen by students and the formation of groups for their study is the basis to include the aforementioned disciplines in the calculation of the workload in relevant departments for the next academic year.

In case a student could not choose the discipline in time due to a serious circumstance or found a mistake in his indication of choice, it is advised to submit the application for enrollment in the study of the chosen discipline to the dean's office, providing relevant documents. A student who has neglected the right to indicate the choice will be included in the study of disciplines considered by the head of the graduating department in order to optimize study groups.

The catalog of elective disciplines of the Department of Biomedical Engineering comprises an annotated list of disciplines offered for selection by students of the second (Master`s) level of HE in accordance with the curriculum for the next academic year:

– first-year students of the Master`s program indicate the choice of disciplines for the second course of training;
– first and second-year students enrolled in the Master's program indicate the choice of the discipline according to their curriculum.

F- Catalog 2021

Disciplines for acquiring professional competencies

(during the 2nd course 23 ECTS credits are chosen)

№	Educational component	Name of academic discipline	Semester	Number of ECTS credits	Semester control
1	EC-1	Artificial organs	2	4	test
2	EC-1	Devices for replacing vital functions of the body	2	4	test
3	EC-1	Design of biomedical information systems	2	4	test
4	EC-2	Endo- and exoprosthetics	2	4	test
5	EC-2	Prosthetic and orthopedic and rehabilitation equipment	2	4	test
6	EC-2	General and laboratory immunology	2	4	test
7	EC-3	Biomaterials and biotechnology	2	4	test
8	EC-3	Physiotherapeutic medical devices	2	4	test
9	EC-3	Fundamentals of genomics and proteinomics	2	4	test
10	EC-4	Electronic sensors and biochip	2	4	test

11	EC-4	Biophotonics and nanoelectronics	2	4	test
12	EC-4	Medical devices and technologies	2	4	test
13	EC-5	Systemic physiology	2	4	test
14	EC-5	Physiology of sensory systems	2	4	test
15	EC-5	Biological pharmacy	2	4	test

Disciplines chosen by students of the 1st year of training

Discipline 1 F-Catalog

Discipline	**Artificial organs**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical Engineering
Entry requirements	Knowledge of medical physics, medical information display systems
What will be studied	History of development of prosthetics of body and individual organs, basic requirements for artificial organs, the degree of approximation of their capabilities to physiological needs, existing and promising technologies of extracorporeal and intracorporeal prosthetics of organs and functions of the human body, requirements for biocompatibility of raw materials and energy supply of artificial organs. Constructive solutions used in the creation of artificial organs and their control systems, problems of rejection of implanted devices, trauma and blood clotting, interface with the CNS and executive bodies, organization of production and service.
Why is it relevant and important	It is interesting to study the discipline, because prosthetics and creation of artificial organs is a modern direction of rehabilitation medicine, which combines the efforts of the most advanced branches of science and technology and is an effective means of restoring lost organs and maintaining vital activity.
What is taught (learning outcomes)	**knowledge:** - basic terms of discipline and their definitions; - fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for prosthetics of human physiological processes; - methods of calculation and selection of classical and new designs, biomaterials, elements, devices and systems for medical purposes; - methods of research, design and construction of biomedical equipment, analysis and processing of experimental data; - principles of development and modern problems of creating biocompatible materials in medical practice;

	- general requirements for the conditions of engineering, technological and scientific projects; **skills:** - design, design, improve and apply medical-technical and bioengineered products, devices, devices and systems in compliance with technical requirements, as well as support their operation; - assess the biological and technical aspects and consequences of the interaction of engineering and bioengineering objects with physiological systems, to anticipate their mutual influence; - anticipate the legal, deontological and moral and ethical consequences of the use of artificial organs and systems for prosthetics; - create and improve tools, methods and technologies of biomedical engineering for comprehensive research and development of artificial organs and systems for medical and technical purposes; - analyze and solve complex medical engineering and bioengineering problems using mathematical methods and information technology.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used to design, calculate parameters and manufacture technical means designed to replace human organs or functional systems.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 2 F-Catalog

Discipline	**Devices for replacing vital functions of the body**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical Engineering
Entry requirements	Knowledge of medical physics, medical information display systems
What will be studied	History of development of substitutes for vital functions of the body, basic requirements for artificial organs, the degree of approximation of their capabilities to physiological needs, existing and promising technologies of extracorporeal and intracorporeal prosthetics of organs and functions of the human body, requirements for biocompatibility of raw materials and artificial organs. Constructive solutions used in the creation of devices to replace vital functions of the body and their control systems, problems of rejection of implanted devices, trauma and blood clotting, interface with the CNS and executive bodies, organization of production and service of such devices.
Why is it relevant and important	It is interesting to study the discipline, because the creation of devices to replace vital functions of the body is a modern effective direction of rehabilitation medicine, which combines the efforts of the most advanced branches of science and technology and is an effective means of restoring lost organ function and maintaining vital activity.
What is taught (learning outcomes)	**knowledge:** - basic terms of discipline and their definitions; - fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for prosthetics of human physiological processes; - methods of calculation and selection of classic and new designs, biocompatible materials, elements, devices and systems for medical purposes; - methods of research, design and construction of biomedical equipment, analysis and processing of experimental data; - principles of development and modern problems of creating biocompatible materials in

	medical practice; - general requirements for the conditions of engineering, technological and scientific projects; **skills:** - to design, construct, improve and apply medical-technical and bioengineered products, devices, devices for replacement of vital functions of an organism with observance of technical requirements, and also to support their operation; - assess the biological and technical aspects and consequences of the interaction of engineering and bioengineering objects with physiological systems, to anticipate their mutual influence; - anticipate the legal, deontological and moral and ethical consequences of the use of devices to replace vital functions of the body; - create and improve tools, methods and technologies of biomedical engineering for comprehensive research and development of artificial organs and systems for medical and technical purposes; - analyze and solve complex medical engineering and bioengineering problems using mathematical methods and information technology.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used to design, calculate parameters and manufacture technical means designed to replace the vital functions of the human body.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 3 F-Catalog

Discipline	**Design of biomedical information systems**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical Engineering
Entry requirements	Principles, methods and means of building medical information systems, medical information resources, interaction of medical information systems using new information technologies, skills of design, development, implementation and operation of medical information systems in health care facilities.
What will be studied	To simplify the work of health care workers by developing medical information systems and implementing business processes in their activities.
Why is it relevant and important	**knowledge:** - basic models and methods of information systems development; - methods of modeling the life cycle of the information system; - basics of business process modeling and development of medical information systems; - basics of software for modeling the life cycle of an information system. **skills:** - to develop algorithms for modeling business processes in medical information systems; - apply methods and algorithms for solving theoretical and applied problems in the field of medical information systems; - to develop complexes of formalization and management of medical information.
What is taught (learning outcomes)	The acquired knowledge and skills can be used to form ideas about methods of informatization of medical staff, automation of clinical trials, informatization of management in the health care system.
How to apply acquired knowledge and skills (competencies)	Principles, methods and means of building medical information systems, medical information resources, interaction of medical information systems using new information technologies, skills of design, development, implementation and operation of medical information systems in health care facilities.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical

	classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 4 F-Catalog

Discipline	**Endo- and exoprosthetics**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of biosafety and human health
Entry requirements	Knowledge of medical physics, medical information display systems
What will be studied	Existing and perspective technologies of extracorporeal and intracorporeal prosthetics of organs and functions of the human body, requirements for biocompatibility of applied raw materials and energy supply of artificial organs.
Why is it relevant and important	It is interesting to study the discipline because it is a modern effective direction of rehabilitation medicine, which combines the efforts of the most advanced branches of science and technology and which is a means of restoring lost organ functions and maintaining vital activity.
What is taught (learning outcomes)	**knowledge:** - basic terms of discipline and their definitions; - fundamental-applied, medical-physical and bio-engineering bases of technologies and equipment for prosthetics of human physiological processes; - methods of calculation and selection of classic and new designs, biocompatible materials, elements, devices and systems for medical purposes; - methods of research, design and construction of biomedical equipment, analysis and processing of experimental data; - principles of development and modern problems of creating biocompatible materials in medical practice; - general requirements for the conditions of engineering, technological and scientific projects; **skills:** - to design, construct, improve and apply medical-technical and bioengineered products, devices, devices for replacement of vital functions of an organism with observance of technical requirements, and also to support their operation; - assess the biological and technical aspects and consequences of the interaction of engineering and bioengineering objects with physiological systems, to anticipate their mutual influence;

	- anticipate the legal, deontological and moral and ethical consequences of the use of devices to replace vital functions of the body; - create and improve tools, methods and technologies of biomedical engineering for comprehensive research and development of artificial organs and systems for medical and technical purposes; - analyze and solve complex medical engineering and bioengineering problems using mathematical methods and information technology.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used to design, calculate parameters and manufacture technical means designed to replace the vital functions of the human body.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 5 F-Catalog

Discipline	**Prosthetic and orthopedic and rehabilitation equipment**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of biosafety and human health
Entry requirements	Knowledge of medical physics, medical information display systems
What will be studied	Existing and promising technologies for the development of prosthetic and orthopedic and rehabilitation equipment, prosthetics of organs and functions of the human body, requirements for biocompatibility of biocompatible materials used and energy supply of artificial organs.
Why is it relevant and important	It is interesting to study the discipline, because it is a modern effective direction of prosthetic and orthopedic and rehabilitation techniques, which combines the efforts of the most advanced branches of science and technology and which is a means of restoring lost organ functions and maintaining vital activity.
What is taught (learning outcomes)	**knowledge:** - basic terms of discipline and their definitions; - fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for prosthetics of human physiological processes; - methods of calculation and selection of classic and new designs, biocompatible materials, elements, devices and systems for medical purposes; - methods of research, design and construction of biomedical equipment, analysis and processing of experimental data; - principles of development and modern problems of creating biocompatible materials in medical practice; - general requirements for the conditions of engineering, technological and scientific projects; **skills:** - to design, construct, improve and apply medical-technical and bioengineered products, devices, devices for replacement of vital functions of an organism with observance of technical requirements, and also to support their operation;

	- assess the biological and technical aspects and consequences of the interaction of engineering and bioengineering objects with physiological systems, to anticipate their mutual influence; - anticipate the legal, deontological and moral and ethical consequences of the use of devices to replace vital functions of the body; - create and improve tools, methods and technologies of biomedical engineering for comprehensive research and development of artificial organs and systems for medical and technical purposes; - analyze and solve complex medical engineering and bioengineering problems using mathematical methods and information technology.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used to design and calculate the parameters of prosthetic and orthopedic and rehabilitation equipment, which is designed to replace the vital functions of the human body.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 6 F-Catalog

Discipline	**General and laboratory immunology**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of translational medical bioengineering
Entry requirements	Knowledge of medical physics, biochemistry, quantitative or systemic human physiology.
What will be studied	Central and peripheral organs of the immune system. The main types of cells of the immune system. Complement, its components. Classic, traditional and lectin ways of complement activation. The main functions of the complement system. Regulation of complement system activation. Chemical nature of antigens. Complete and incomplete antigens. Genetic foreignness, specificity, antigenicity and immunogenicity of antigens. General structure of antibodies. Heavy and light chains of immunoglobulins. The structure of the active site of antibodies. Hypervariable regions of antibodies. Structure of MHC molecules of I and II class. Functions of histocompatibility antigens.
Why is it relevant and important	Development and implementation of principles and methods of immunodiagnostics and immunoassay for obtaining modern diagnostic, immunomodulatory and immunotherapeutic drugs and their use in practice. To form a system of knowledge of the features of pathological processes with the participation of immune mechanisms. Explain the development of processes associated with differentiation, proliferation and programmed cell death.
What is taught (learning outcomes)	**knowledge:** - modern methods of immunological tests: flow cytometry, polymerase chain reaction, enzyme-linked immunosorbent assay; - causes of false-positive and false-negative results in diagnosis; - reactions to determine the number and functional activity of lymphocytes; - humoral factors of nonspecific resistance: complement, acute phase proteins, cytotoxic factors, natural immunoglobulins; - immunogenicity of different classes of biopolymers;

	- features of the structure and function of immunoglobulins of different classes (IgM, IgG, IgA, IgE, IgD); - structures of MHC molecules of I and II class, functions of histocompatibility antigens; - features of recognition of foreign systems of natural and acquired immunity; - cytokines and their receptors. **skills:** - to conduct immunological tests; - to determine the levels of antibodies using the enzyme-linked immunosorbent assay; - perform identification of cells of the immune system; - to determine the indicators of the humoral part of the immune system; - determine the level of cytokines; - to determine the functional activity of phagocytic cells.
How to apply acquired knowledge and skills (competencies)	To determine the humoral factors of nonspecific resistance. Determine immunocompetent cells, antibody level, concentration of complement system. Determine the level of pro and anti-inflammatory cytokines, interferons.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 7 F-Catalog

Discipline	**Biomaterials and biotechnology**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of translational medical bioengineering
Entry requirements	Knowledge of bachelor's degrees "Biomaterials and biocompatibility", "Medical biotechnology"
What will be studied	Existing and promising biocompatible biomaterials with specified properties for the production of medical devices, design and development of artificial organs and systems, taking into account the requirements for biocompatibility of biomaterials that must be in contact with the living organism.
Why is it relevant and important	The modern direction of biomaterials and biotechnology is the creation of biocompatible materials with specified properties that allow them to be used for the development and modeling of materials for reconstructive surgery, dentistry, traumatology, diagnostics and drug delivery systems.
What is taught (learning outcomes)	**knowledge:** - methods and means of selection of biomaterial in accordance with the terms of reference in the design of medical devices; - principles of development and modern problems of creating biocompatible materials in medical practice; - methods and means of research of biomaterials with the set properties contacting with a biological environment; - principles of development and modern problems of basic methods of research of new materials in biomedical engineering **skills:** - apply the acquired knowledge to the choice of material in accordance with the terms of reference in the design of medical devices; - assess the biological aspects and consequences of the interaction of bioengineered objects with physiological systems; - to analyze the dependence of the properties of medical material on various parameters.

How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used for the production of diagnostic tools for molecular imaging and targeted delivery of drugs, design and development of artificial organs and systems, taking into account the biocompatibility of biomaterials that should be in contact with the living environment.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 8 F-Catalog

Discipline	**Physiotherapeutic medical devices**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical engineering
Entry requirements	Knowledge of the basics of the propagation of electromagnetic radiation in different environments, biochemical features of the functioning of internal organs and the human body as a whole.
What will be studied	General concepts of features of medical equipment for further action in diseases of the cardiovascular system of the human body, basic terms and definitions. Electronic devices of therapy in medical equipment and their classification. The main tasks of design and requirements for modern medical equipment. Different distributions of therapeutic equipment by functional complexity. Features of protocols of general procedures of physiotherapy. The effect of aeroionotherapy. Apparatus for electroaerosol therapy. The main modern ways of influencing the electric field on the human body and the heart. Apparatus of therapy in inpatient and outpatient settings, indication and transmission of information during visualization and registration, the main criteria for choosing the type of transmission of information. Adjustment of the immune system of the human body by hardware. Modern devices for rehabilitation of human diseases. Features of rehabilitation by means of infrared and visible irradiation of skin and blood of the person. The principle of operation and main characteristics of modern laser medical and diagnostic complexes for rehabilitation.
Why is it relevant and important	Modern medical rehabilitation equipment widely uses the latest advances in laser technology, electronics.

What is taught (learning outcomes)	**knowledge:** – universal principles of structure of complex biological systems, including the human body; - methods of statistical processing, modeling and simulation of processes and systems of physical and biological nature; - the main methods and tools used for quantification functioning of physiological systems; - methods of application of signal theory and methods of signal research and images in the specialty of biomedical engineering; - basic operating conditions of diagnostic and therapeutic systems, medical complexes and systems; - means of designing devices, devices and systems for medical and biological purposes; - research methods and techniques used in design medical equipment. **skills:** - to develop and implement modern diagnostic and treatment methods, related to the use of biotechnology, computer and nanotechnology; - use computer-aided design systems for development technological and hardware scheme of medical devices and systems; - select and recommend appropriate medical equipment and biomaterials to equip medical facilities and provide basic stages of the technological process of diagnosis, prevention and treatment; - provide recommendations on the choice of equipment to ensure the conduct diagnosis and treatment; - provide engineering support, service and other maintenance during operation of laboratory-analytical equipment, medical diagnostic and therapeutic complexes and systems, as well as draw up standard documentation by types of work in accordance with the Technical Regulations for medical devices; - use databases, math and software for data processing and computer modeling of biotechnical systems.
How to apply acquired knowledge and skills (competencies)	Acquired knowledge and skills (competencies) can be used when working with modern medical laser physiotherapy equipment, to carry out its

	modernization, maintenance and repair.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 9 F-Catalog

Discipline	**Fundamentals of genomics and proteinomics**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of translational medical bioengineering
Entry requirements	Knowledge of the basics of computer science, anatomy and physiology of man, biochemical features of the functioning of internal organs and the human body as a whole.
What will be studied	Features of computer science and genetics for processing and presentation of information in medical information systems, standards of transmission and storage of genetic information. Basic methods and principles of genetics. Fundamentals of population genetics. Application of special knowledge in the field of computer science and computer engineering to solve interdisciplinary engineering problems
Why is it relevant and important	Recent advances in molecular biology and genetics have necessitated the development of bioinformatics. The use of bioinformatics methods to solve fundamental and applied problems of molecular biology, molecular genetics. Creation of banks of primary sequences and structures of biological molecules, use of genomic database.
What is taught (learning outcomes)	**knowledge:** - comparative genomics, bioinformation databases; - methods and basic algorithms of bioinformatics; - methods of comparing the primary structures of biopolymer molecules; - algorithms for comparing the sequences of amino acids and nucleotides; - information content of genetic sequences; - recognition of areas of hidden periodicities; - mechanisms of formation of spatial structures of biological macromolecules; - banks of protein structures; **skills:** - integrated study of genomes; - genomic analysis and structural genomics; - use genomic projects; - computer modeling of biological molecules; - work with polypeptide structural data banks

	- to determine the genes of diseases; - analyze information from nucleotide and polypeptide banks.
How to apply acquired knowledge and skills (competencies)	The use of bioinformatics to analyze the organization and structure of genes and genomes of plasmids. Determination of levels of molecular organization of genomes, structural components of genomes.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 10 F-Catalog

Discipline	**Electronic sensors and biochip**
Level of higher education	Second (Master`s)
Course	2
Scope	4 ECTS credits
Language of instruction	English
Department	Microelectronics department FEL
Entry requirements	Knowledge of bachelor's degrees "Physics", "Electrical Engineering and Electronics", "Digital Circuitry", "Microprocessor Engineering"
What will be studied	Electronic sensors and biochips used in medical technology and their classification. The main tasks of design and requirements for modern medical equipment. The principle of operation and main characteristics of electronic sensors and biochips used in modern medical and diagnostic complexes.
Why is it relevant and important	It is interesting to study the discipline, because it is the basis for the preparation of certification work for the successful completion of training in the specialty. Gain the ability to be critical and self-critical.
What is taught (learning outcomes)	**knowledge:** – basic methods and tools used for quantification functioning of physiological systems; - universal principles of structure of complex biological systems, including the human body; - methods of statistical processing, modeling and simulation of processes and systems of physical and biological nature; - methods of application of signal theory and methods of signal research and images in the specialty of biomedical engineering; - basic operating conditions of diagnostic and therapeutic systems, medical complexes and systems; - means of designing devices, devices and systems for medical and biological purposes; - research methods and techniques used in design medical equipment. **skills:** - to develop and implement modern diagnostic and treatment methods, related to the use of biotechnology, computer and nanotechnology; - use computer-aided design systems for development

	technological and hardware scheme of medical devices and systems; - select and recommend appropriate medical equipment and biomaterials to equip medical facilities and provide basic stages of the technological process of diagnosis, prevention and treatment; - provide recommendations on the choice of equipment to ensure the conduct diagnosis and treatment.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills will allow to use modern methods of development of electronic sensors and biochips which are used in modern medical and diagnostic complexes.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 11 F-Catalog

Discipline	**Biophotonics and nanoelectronics**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Microelectronics department FEL
Entry requirements	Knowledge of bachelor's degrees "Physics", "Biophysics and Biomechanics", "Biothermodynamics and Mass Transfer"
What will be studied	The main processes at the cellular level of biological media under the action of laser and ultraviolet radiation, as well as the study of the parameters of biological objects at the molecular level using modern electronic diagnostic equipment used to study human diseases.
Why is it relevant and important	Discipline allows you to develop the ability to analyze, research, operate, repair modern complex diagnostic equipment, design devices, taking into account the relationships between the structure and properties of materials, the impact of external physical factors.
What is taught (learning outcomes)	**knowledge:** - basic principles of functioning of modern high-tech diagnostic medical equipment; - modern methods of computer examination and modeling of inflammatory processes in the human body using the latest methods and algorithms for analyzing the results of biomedical research at the cellular level. **skills:** - design, develop, construct and repair modern electronic equipment for biomedical research of human diseases; - repair of modern complex diagnostic equipment, design of devices, taking into account the links between the structure and properties of materials.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills will allow to use modern methods of computer examination and modeling of inflammatory processes in the human body. The acquired competencies will allow repairing complex diagnostic equipment, designing devices, taking into account the links between the structure and properties of materials.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical

	classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 12 F-Catalog

Discipline	**Medical devices and technologies**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Microelectronics department FEL
Entry requirements	Knowledge of higher mathematics, physics, biochemistry, mechanics, biophysics, basics of analog and digital circuitry.
What will be studied	Modern medical equipment, directions of its development, maintenance and inspection, types of medical equipment, general principles of functioning as intended and maintenance.
Why is it relevant and important	The development of modern medical devices requires the study of general principles of maintenance and metrological certification of equipment, technology of organization of work with medical equipment in treatment and prevention facilities.
What is taught (learning outcomes)	**knowledge:** - features of the domestic market of medical equipment; - organization of work with medical equipment in treatment and prevention facilities; - safety standards when working with medical equipment; - maintenance and metrological certification of equipment; **skills:** - work with regulatory documents governing the maintenance of medical equipment and medical supplies; - preparation of tender documentation for the purchase of medical equipment.
How to apply acquired knowledge and skills (competencies)	Acquired knowledge and skills (competencies) will allow for maintenance and metrological certification of equipment, to understand the technology of organization of work with medical equipment in treatment and prevention facilities.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 13 F-Catalog

Discipline	**Systemic physiology**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical engineering
Entry requirements	Knowledge of the basics of anatomy, physiology, human biochemistry, mathematics.
What will be studied	Quantitative characteristics of electromagnetic processes in the body; origin of bioelectric signals and their characteristics; EEG principles; ECG signal generation; calculation and graphical reproduction of the heart; determinants of heart function and their relationship; interaction of the heart and blood vessels, the formation and propagation of pulse waves in the cardiovascular system; electrical circuit of the cardiovascular system; basic laws of hemodynamics and methods of studying the cardiovascular system; hemodynamic paradoxes; mass transfer characteristics of the lungs; direct and indirect methods of research of respiratory function; assessment of renal function; systems of support and replacement of secretory functions
Why is it relevant and important	It is interesting to study the discipline, because understanding the relationship between physiological parameters, knowledge of ranges is a necessary basis for the creation of biotechnical means to support or replace vital functions of the body.
What is taught (learning outcomes)	**knowledge:** - basic physical and physicochemical patterns of functioning of biological objects; - general information about the human body and its functions from the standpoint of a systems approach and their use in biomedical engineering universal principles of structure of complex biological systems, including the human body; - the main methods and tools used to quantify and analyze the functioning of physiological systems; **skills:** - identify the relationships between physiological parameters; - to find similarities and differences of functional systems of the human body and engineering devices and automatic systems;

	- to use methods and means of quantitative assessment of the functioning of physiological systems in practical engineering activities.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used in the analysis, modeling of the functioning of living organisms and biotechnical systems.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 14 F-Catalog

Discipline	**Physiology of sensory systems**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Biomedical engineering
Entry requirements	Knowledge of the basics of anatomy, physiology, human biochemistry, mathematics.
What will be studied	Principles of a systematic approach to the study of biological objects; systems for maintaining homeostasis of the human body; origin of bioelectric signals and their characteristics; membrane potential of rest and action; dissemination of action potential; quantitative electrophysiology of the brain; quantitative electrophysiology of the heart; characteristics of the heart as a pump; interaction of the heart and blood vessels, the formation and propagation of pulse waves in the cardiovascular system, their characteristics; electrical circuit of the cardiovascular system; basic laws of hemodynamics; transfer of substances in the capillary network; methods of research of cardiovascular system; mass transfer characteristics of the lungs; methods of research of respiratory function; assessment of renal function; systems of support and replacement of secretory functions.
Why is it relevant and important	Understanding the system is equivalent to creating its model. Using an analytical and quantitative approach to the study of physiology, such as excitatory tissue physiology, cardiovascular system, respiratory and excretory system, allows us to understand the relationships between physiological parameters, which is necessary for modeling and creating modern biotechnical systems.
What is taught (learning outcomes)	**knowledge:** - numerical values for ranges of the most important aspects of physiology, such as flows or forces inside the body; - basic physical and physico-chemical laws of functioning of biological objects; - universal principles of structure of complex biological systems, including the human body; - the main methods and tools used to quantify and

	analyze the functioning of physiological systems; - understanding of the human body as a control system that uses negative feedback, positive feedback, anticipatory and threshold mechanisms. **skills:** - apply knowledge of the basics of natural sciences at the level necessary to solve the problems of biomedical engineering; - to find similarities and differences of functional systems of the human body and engineering devices and automatic systems; - to use methods and means of quantitative assessment of the functioning of physiological systems in practical engineering activities.
How to apply acquired knowledge and skills (competencies)	The acquired knowledge and skills can be used in the analysis, modeling of the functioning of living organisms and biotechnical systems.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test

Discipline 15 F-Catalog

Discipline	**Biological pharmacy**
Level of higher education	Second (Master`s)
Course	1
Scope	4 ECTS credits
Language of instruction	English
Department	Department of translational medical bioengineering
Entry requirements	The study of this discipline is preceded by the study of disciplines: physics, chemistry, biochemistry, as well as the basics of human physiology (disciplines of human anatomy and physiology).
What will be studied	Chemical bases of vital processes of an organism which obey the basic chemical laws. Structure and reactivity of the most important biologically active molecules, the theory of chemical bonding in complex compounds of biometals with bioligands and the role of nutrients in the life of the organism. Physico-chemical processes that occur at the molecular and submolecular levels, because this is where the causes of various forms of disease and the specificity of hereditary traits.
Why is it relevant and important	For specialists in biomedical engineering and related fields (chemical and bioengineering), whose activities are aimed at the medical application of their technologies and products, it is important to understand the physicochemical and pharmacological basis of the effects of physiologically active substances on the human body. Such substances can be of chemical, biological (natural) or biotechnological origin. Understanding the patterns of influence of biological, physical and chemical factors on the effectiveness of the use of physiologically active substances is critical for the development of a significant part of biomedical technologies and products.
What is taught (learning outcomes)	**knowledge:** − properties and methods of expressing the composition of solutions; - classification and nomenclature of inorganic compounds; - basic concepts and laws of chemistry and methods of their use to solve applications tasks; - basic laws of chemical reactions of different types; - classification and principles of titrimetric and physicochemical research methods;

	- regularities of adsorption of substances from solutions on a solid surface; - basic patterns of influence of various factors on the therapeutic activity of drugs; - basics of general pharmacology. **skills:** - to interpret the main types of chemical equilibrium for the formation of a holistic physico-chemical approach to the study of the processes of the organism in normal and pathology; - apply chemical and physico-chemical methods of quantitative and qualitative analysis and draw conclusions about the possibility of their use in medical and biological research; - to classify chemical properties and transformation of bioinorganic substances in the course of vital activity of an organism; - to interpret the general physical and chemical laws that underlie the processes of human life; - distribute drugs by pharmacological groups; - to find in the reference literature new drugs in the relevant pharmacological groups.
How to apply acquired knowledge and skills (competencies)	Chemical and biological studies of substances (including biological origin) with pharmacological activity. Development of drugs, medical devices and other pharmaceutical products containing physiologically active substances.
Information resources	Educational and working programs of the discipline, RSE, textbook (electronic edition), syllabus, online course on Moodle, practical classes, laboratory works URL: https://do.ipo.kpi.ua
Form of study	Lectures, practical classes
Semester control	test