

## **SUMMARIES OF THE COURSES**

for the master's program

«Systems and technologies in Digital HealthCare»

Educational direction

12.04.04 «Bioengineering Systems and Technologies»

### **«Social Communication in a Professional Environment»**

The main objective of the course is to develop the ability of students to critical analysis of specific communicative practices and situations of interpersonal interaction and also management skills of communicative behavior in the business interaction. Specific topics are focused on basic communication skills in a business environment, techniques of group management and of making group decisions, the rules of business written communication and business telephone communication.

### **«Methods of Computer Processing and Analysis of Medical and Biological Data»**

The course covers main directions of biomedical data analysis. Special attention is paid to the machine learning methods. Different approaches to solving classification problems (linear Fisher discriminant, logistic regression, k-nearest neighbors method, support vector machine, decision trees) and clustering (DBSCAN method, k-means, hierarchical clustering), reduction of space dimension (principal component method) are being discussed as well as determination of significant features (selection algorithms). At the practical classes, students work in the MATLAB software environment, implement the analysis methods which have discussed on the lectures and become familiar with the data visualization approaches.

### **«Commercialization of Results of Scientific Research and Development»**

Commercialization of the research work results is the process of involving them in the economic (commercial) turnover in order to ensure the innovative

development of the national and international economy. The relevance of this discipline is due to the need to modernize the economy in the context of changing the existing technological structure based on the realization of the potential of high-tech branches of science and technology, including the «Digital Economy» program. The development and implementation of the research work results in the economic activities of organizations and enterprises is one of the key success factors for economic transformations. The main goal of this discipline is to form a complex of knowledge, skills and practical skills of developing a business plan for the commercialization of innovative ideas in the form of creating new or improved types of products, goods, works and services studied in the course of R & D undergraduates. Mastering a phased methodology for business planning and design of various innovative projects will ensure the acquisition of competencies required in solving the problems of outputting the results to sales markets and assessing their economic efficiency.

### **«Modern Problems of Biomedical Engineering»**

The discipline is intended for students studying in medical-technical areas of education. This course introduces students with the current problems and the most promising areas of biomedical engineering. In particular, the issues of application of nanotechnology in medicine, various types of medical robots, modern X-ray techniques, telemedicine, systems for contactless recording of human physiological indicators are considered. The study of the discipline will allow future masters to more freely navigate the main problems of basic and applied research in the field of biomedical engineering, to identify its promising areas and practical applications.

### **«Bioengineering Systems and Technologies»**

The discipline purpose is to form the student's knowledge in methodology and basic principles of biomedical engineering systems development, problems of modeling, synthesis and research of biomedical engineering systems, development

of the generalized system's structure, research of biomedical engineering system's information interaction and control channels, structures of the information and methodical support, hardware, software and metrological support for biomedical engineering systems development, forming of professional skills and competencies for biomedical engineering systems synthesis for diagnostics and patient's disorders treatment, patient's health control, monitoring and prediction.

### **«Russian as a Foreign Language»**

The discipline is intended for education of master's degree non-philological foreign students, who have the bachelor diploma of Russian institute of higher education and have the knowledge of Russian Language corresponding to the B 2 level. The program includes requirements for language knowledge level in different types of speech activity as well as grammar and speech material.

The mastering of this program will allow the foreign students to handle their communicative needs in educational, social and cultural sphere, will produce the base for successful learning of special subjects, and, as a result – for successful presentation of a thesis.

The Russian Language course for master's degree students must ensure the forming of a graduate's communicative competence on the level sufficient for professional activity in Russian Language. The education is realized on the source of general scientific, country-specific, literary, social and political texts.

### **«Foreign Language»**

This program is pointed on providing training courses for foreign citizens who had not studied the Russian language before. It includes language and speech models based on the requirements for the Elementary certification level. Achieving this level in Russian will satisfy the foreign students' basic communicative demands in social and cultural as well as in educational spheres of communication.

The content of the program involves implementation of flexible training models, depending on the communicative purposes, native language and students' individual features.

### **«Monitoring Systems in Digital HealthCare»**

After finishing the course «Monitoring Systems in Digital Healthcare», students will get basic knowledge of the main biomedical signals used to assess the current health state of a person in telemedicine monitoring systems, such as electrocardiogram, pulse wave, blood pressure, respiration rate and others. In practical classes, students will study basic set of sensors for the registration of biomedical signals, current trends and approaches to the instrumental support of systems for remote monitoring in digital healthcare. During laboratory works, students will gain practical skills in registering signals using a modern Biopac Student Lab system, an integrated life science teaching solution that includes hardware, software and curriculum materials that students use in undergraduate laboratories to record and processing data from their own bodies.

### **«Telemedicine Systems and Technologies»**

The discipline purpose is to form the student's knowledge in methodology and basic principles of development of telemedicine systems for remote diagnostics and treatment. The main classes of telemedicine systems and tasks solved them; generalized structures and variants of development of systems for diagnostics and treatment of patients with chronicle diseases, problems of autonomy, continuous operation, and reliability of diagnostics and prognostics of the diseases exacerbation are considered.

### **«Bases of Management and Marketing at Medical Industry Enterprise»**

The discipline is intended for students studying in medical-technical areas of education. The course covers issues related to planning and managing the marketing activities of an enterprise, in particular: the marketing concept, types of

marketing research, methods for assessing the competitiveness of high-tech products, pricing techniques, components of the demand generation and sales promotion system and the main types and categories of services in medical and technical enterprises profile. The system of development and introduction of medical devices, the procedure for registration of medical devices in the Russian Federation and the Eurasian Union, as well as the main directions of foreign economic activity enterprises are considered.

### **«Automated Analysis of Images»**

The discipline is devoted to study of the images analysis and processing problems. The problems of automated analysis and digital images processing, methods and software are discussed. The accent is focused at the analysis and processing of biomedical images. The issue of images forming by using of different converters and optical systems are studied. The attention is focused at the image transformation and processing at the visual system. The problem of development of automated images analysis is discussed. Received theoretical knowledge is reinforced by the implementation of the automated images analysis methods at the laboratory lessons.

### **«Automation of Biomedical Research»**

This discipline provides professional training in the fields of bioengineering systems and human control systems. It covers innovative technologies, which are used for automation of biomedical research as well as basic principles of construction of systems that implement these technologies. The course examines the problems taking place during synthesis of this kind of systems, and in the course of their methodical, informational and instrumental support. The theoretical aspects of the automated research systems development are supplemented by the practical aspects of their application.

The discipline is important for the development of the professional competence of the specialists involved in the design and use of the technical tools for the biomedical research automation.

### **«Interdisciplinary Project**

#### **«Development of Monitoring System for Outpatients with Chronic Diseases»**

The discipline purpose is systematization, strengthening and extension of the theoretical and practical knowledge of students, application of knowledge to solve concrete scientific and engineering problems of system development for patient's health remote monitoring with chronic diseases. During fulfillment of the interdisciplinary project students develop and design the structure and elements of the remote monitoring system, form the ability to carry out the review and substantiation of the way for purpose achievement, form the skills for practical use of knowledge and ability to develop remote monitoring systems.

### **«Information systems in Digital HealthCare»**

Health information technology is becoming more and more, an integral part of our healthcare system and is invaluable to both treating patients and evaluating treatment regimes of any national health system of any country. Implementation of more advanced technologies has: greatly improved the quality of health services, the quality of patient healthcare, reducing the cost of health and care services. Health care information systems can give patients more control over their health, reduce the administrative burden for care professionals, improve clinical outcomes, enhance decision support, enable accurate reporting of data, improve the security of information (paper-based versus and electronic systems) as well as improve patient access to information support the development of new treatments and medicines.

This Masters' level course introduces the fundamentals of information systems used for: managerial and clinical support in healthcare; comparison to healthcare systems in other countries; electronic health records and the use of

medical databases; further exploration of medical databases and manipulation for decision support including evidence-based practice. Students will learn how to use medical databases, store and use statistical tools such as IBM SPSS statistics and IBM SPSS Modeler for evidence-based clinical research. The course has been designed to give both theoretical and practical knowledge.

### **«Maintenance and Repair of Modern Medical Equipment»**

The course deals with the installation, commissioning, control of the technical condition, periodic and routine maintenance, repair of medical equipment. After studying the basic principles and legislative issues, the specifics of the implementation of the declared processes are considered in relation to certain types of medical equipment: X-ray, computed tomography scanners, ultrasound scanners, anesthetic, resuscitation devices, disinfection equipment, laboratory equipment, functional diagnostic equipment etc. During practical classes students develop a plan for technical maintenance and perform tasks of finding and eliminating of typical malfunctions.

### **«Advanced Methods and Tools for Biomedical Data Analysis»**

The course program includes studying and analyzing basic machine learning algorithms with an emphasis on their mathematical description and specific properties of biomedical datasets. The issues of data preparation, selection of significant features, variance analysis, decision trees and forests, neural networks and Big Data technologies are discussed. In practical and laboratory classes, students learn to apply theoretical knowledge to practical problems of biomedical data analysis using Python programming language. Specialized mathematical Python modules, which are mandatory for modern specialists in the field of data analysis, are studied. The course is aimed at students who are familiar with the basics of statistics and data analysis methods.

### **«Motion Analysis Systems and Technologies»**

This is an introductory course in movement and gait analysis. It will help students to learn modern technologies for movement analysis using: optical motion capture systems, Inertial Measurement Units, EMG systems, force platforms, plantar pressure measurement and others. The main aim of this course is to introduce students to the techniques and methods of gait analysis and give them knowledge and tools to solve biomechanical problems, robotics, to improve rehabilitation techniques, research and treatments programs for people with different disabilities of the musculoskeletal system. Successful completion of this course will enable the student to acquire advanced knowledge of biomechanical mechanisms of human gait and to develop experience in the use of selected biomechanical measurements and analysis methods such as kinematic, kinetic, plantar pressures analysis, and joint modelling.

### **«Design of Digital Medical Systems»**

Discipline provides professional training in the design of diagnostic and therapeutic biomedical electronic systems using modern computer-aided design systems, such as MicroCap and Altium Designer. The main methods of finding technical solutions in the design of electronic systems designed to solve various practical problems are mentioned. The general theoretical and methodological information presented in the course of lectures is illustrated with specific examples and techniques for designing, calculating and simulating real modern diagnostic electronic systems. This discipline serves as the foundation for the formation of a scientific and engineering approach in the field of design and industrial production of new and development of existing biomedical systems, and helps to form in the student the skills of a systems approach to solving complex engineering problems.

### **«Simulation on Bioengineering Systems»**

The discipline is dedicated to modeling in biomedical engineering and is aimed on widening the knowledge and experience in applying mathematical



apparatus for different applications in medical and technical sciences. Current course contains fundamental knowledge on modeling and system theory along with practical aspects for each topic provided in the course program. Learning material covers a broad range of data-driven and theoretical models, including models based on differential equations, finite-state machines, Markov chains, queueing systems, Petri nets and time series among others. The course is supplemented with laboratory works dedicated to aspects of data-driven modeling in MATLAB, Simulink and R.

### **«Special Aspects of Designing for Safe Device Techniques»**

Discipline devoted to study the general technical aspects of complex safety, which contain concept, principles of design and construction, which can be used for all device technologies and systems. Primary attention is paid to the requirements for the tests according to the standards of safety at the all stages of the life cycle. Special features of device systems are examined from the potential danger point of view, created by electric current, fire and explosion, electromagnetic fields, mechanical, climatic actions and human factors.

### **«Academic Internship (Engineering and Manufacturing)»**

#### **«Internship (Research Project)»**

#### **«Internship (Pre-degree Internship)»**

### **«State Final Examination»**

The State final attestation includes defense of the graduation qualification work. The State final attestation is the last mastering stage of the basic educational program.

The training level of graduates for performance of their professional tasks and compliance of their training with the requirements of the State Standard are assessed in the course of the State final attestation.

## **«Laser Systems»**

Course contains information about physical fundamentals and design of modern laser systems. Requirements to laser systems, used in science and industry, are analyzed. Main characteristics and technical features of laser systems are presented. Applications of laser systems in industry, environmental monitoring, optical communication and biomedicine are discussed.

## **«History of Bioengineering Systems»**

The discipline purpose is to form the student's knowledge in evolution history of biomedical engineering systems. The main ways and stages of such system's evolution from the apparatus for electro physiological signals registration and processing to modern telemedical systems for diagnostics, monitoring and control of the patients health state, fulfillment of the minimally invasive and laparoscopy surgical operation, transplantation of the organs, NBIC systems improving the HealthCare quality are considered.