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WP1 BIOART Report

Evaluation on Existing Curricula

P11 Donbas State Engineering Academy

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The state and development perspectives of the medical specialties in the DSEA

Section 1. The current situation in the DSEA

The medical specialties' curricula of this year's bachelor's degree students was approved on the meeting of the DSEA Academic Council (minutes No. 7 dated March 30, 2017). They are aimed at preparing technical specialists for the needs of medical institutions. In accordance with the accepted course for medical reform in Ukraine they should implement modern medical equipment, provide its high-quality information and technical service.

During the 2017-2018 academic year, the training of bachelors in the field of medical specialization is carried out by the departments of Computer and Information Technology (CIT), Automation of Production Processes (APP), Computerized Mechatronic Systems, Tools and Technologies (CMS) of the DSEA (table 1).

Table 1 – List of medical specialties during the 2017-2018 academic year

Code and the name of the field of knowledge	Code and name of specialty	Medical specialization	Department	Number of students	
				2nd course	3nd course
12 Information Technology	122 Computer Science	Information technology in medicine	CIT	2	10
13 Mechanical engineering	133 Sectoral engineering	Production of medical equipment and tools	CMS	5	0
15 Automation and instrumentation	151 Automation and computer-integrated technologies	Control systems and microprocessors for biometric use	APP	2	10

At the CMS Department 5 students of the 2nd year will only begin to study medical disciplines at the end of this academic year. The departments of CIT and APP have accumulated some experience in the field of new specialization by the last academic year. Part of the disciplines of the curriculum is of general purpose for the whole specialty of the departments, but the other part is of purely medical purpose and requires special training of teachers. The source of information for teachers is the experience of other higher educational institutions of Ukraine and foreign universities, as well as of foreign textbooks and scientific works on specific subjects.

Disciplines of medical appointment are common for the corresponding specializations, studied by the students of the CIT and APP departments. Main disciplines of professional training bachelor's curricula are shown in Table 2.

Disciplines of the medical field are not foreseen in the masters' curriculum, but they are planned to be implemented in a year.

Table 2 - Disciplines of the medical field of the bachelors' curricula

№	Name of the discipline	Volume in hours	Semester
1	Anatomy and physiology of man	45	1
2	Medical terminology and Latin language	45	2
3	Biomechanics	45	3
4	Nodes and elements of medical equipment	60	3
5	Biotechnical systems and technologies	90	4
6	Mathematical modeling of processes and systems	90	6
7	Computer technologies in medical biology research	90	are planned
8	Methods of mathematical processing of medical and biological data	90	are planned

The example of the content of special medical disciplines studied by the students of the CIT and APP departments follows.

Disciplines "Anatomy and Physiology of Man", "Medical Terminology and Latin Language".

The purpose of these disciplines is to study anatomy of a person so that a specialist in the technical field at the workplace in medical institutions could interact with specialists in the field of medicine.

The disciplines "Human Anatomy and Physiology" and "Medical Terminology and the Latin Language" are basic and are taught by the specialists of the Donetsk National Medical University in Kramatorsk according to the relevant programs.

Equipment. For better mastering of these disciplines equipment is needed, such as a computer and a helmet of virtual reality. Software is also required – Human Atlas for viewing 3D models.

Discipline "Medical Biomechanics"

The aim of the discipline is to obtain by bachelor's degree students of fundamental knowledge that corresponds to the existing international standards of higher education and includes knowledge of biomechanics – the science, which, based on ideas and methods of mechanics, studies the properties of biological objects (muscle and bone tissues), patterns of their adaptation to the environment; behavior and mechanical movements in them at all levels of organization and in different conditions, including periods of development and aging, as well as pathologies. Biomechanics is used for medical diagnostics, creation of substitutes for tissues and organs, for the development of methods for influencing processes in living organisms, for the knowledge of motor capabilities of a person, to protect humans from harmful effects of the environment during operation under extreme conditions. The main task of studying the discipline is to instruct students to use the basic laws of biomechanics in their professional activities.

The discipline of biomechanics provides knowledge and skills for students in the field of modeling human movement and designing elements of human body, elements of structures that provide prosthetics, load parameters control, muscle training, and more.

Equipment. For practical mastering of the discipline, the means of controlling the mechanical characteristics of the materials are required: the installation for stretching, compression, bending of samples, and so on. Software is also needed for designing and simulating 3D objects: CAD and CAE systems.

Discipline „Nodes and elements of medical equipment"

Purpose of the discipline: the study of the basic circuit design and principles of medical equipment nodes construction for modern diagnostic and therapeutic equipment.

Tasks of the discipline: acquaintance of students with the elemental base of units construction of medical equipment, principles of its work and main characteristics; obtaining knowledge by students about the features of circuit design solutions of the main units of modern diagnostic and medical electronic equipment; acquaintance with computer technologies of calculation, designing and modeling of medical equipment units.

Basic didactic units of discipline: terminology of discipline, main groups of electronic medical devices and apparatus, generalized system of obtaining medical and biological information, biopotentiometer amplifiers, linear transformers and filters on operational amplifiers, nonlinear analogue converter transducers, analogue memory elements, signal generators for medical equipment, modulators and phase-sensitive detectors, devices of continuously discrete signal transformation and secondary sources of power supply, interiors faxes for connection of medical equipment units to microprocessors, microcontrollers and PCs, computer technologies for designing medical equipment nodes, perspectives for the development of medical equipment.

The discipline's laboratory cycle involves implementation of a series of laboratory works devoted to the modeling of nodes of different types and appointment based on operational amplifiers using the software environment simulation of electronic equipment.

Equipment. In order to enhance the practical orientation of mastering the disciplines, "Medical Biomechanics" and "Nodes and Components of Medical Technology", sensors and built-in computerized systems that are components of medical equipment are needed. In addition, for the repair and manufacture of implants it is necessary to use equipment with CNC: turning and milling machine, 3D printer. Therefore, for realization the SAM system is required for CNC operation. These technologies, in combination with CAD and CAE systems form a complete cycle of implant production.

Discipline "Biotechnology Systems and Technologies (BST)"

The BST discipline requires the students prior knowledge of the courses of anatomy and physiology, higher mathematics (integration of differential equations), general physics, theoretical (technical) mechanics, as well as computer science, programming and work with systems of computer algebra.

As a part of the BST discipline, students study the elements of hydraulics, rheology and similarity theory for the human body on the examples of solving various applied tasks.

Discipline "Mathematical Modeling of Processes and Systems" (MMPS)

The discipline MMPS requires the students prior knowledge of the courses of anatomy and physiology, biotechnology systems and technologies, higher mathematics and numerical methods, partial differential equations and differential algebraic equations, general physics, theoretical mechanics, electromechanics, the theory of automatic control, automated electric

drive, nodes and elements of medical equipment, as well as computer science and work with the MathLab system.

The aim of the course is to familiarize students with the computing capabilities of modern simulation systems, such as MathLab and SciLab, for mathematical modeling, numerical integration, visualization, optimization, and verification of mechanical and multifix phenomena, processes and dynamic systems in biomedical engineering, biomechanics, physiology, and medicine.

Equipment. To improve the quality of simulation software development tools, imitation simulation systems are needed.

To implement the technology of remote work with the equipment, software is required to be integrated with the MOODLE remote education system.

Section 2. Analysis of the labor market, preliminary work

The developments of the departments for the educational process of medical appointment specializations.

Within the framework of preparation activity for the commencement of medical specialization at the departments of CIT and APP, the analysis of the state of the issue of training specialists in the field of information technologies, microcircuit engineering, medicine, bioengineering, connections are established with the departments of VNTU Vinnytsya and PSTU Mariupol, ONTU Odesa, which prepare students of the bioengineering specialty. On this basis, bachelors' curricula have been developed, including disciplines and areas of practical training, which are necessary for mastering these specializations. The basis of the specialization is mastering of schematic diagrams of medical equipment designs along with basic software products and specialized software technologies that use computers of various designs, including embedded computer systems.

Practical training of students in the specialty "Control systems and microchip technology of biometric designation" assumes a wide use, during the practical cycle of training, of the software environment for simulation of radio electronic equipment. The software package makes it possible to carry out a large number of studies of various radio electronic devices much more quickly than with standard methods of research.

The presence of virtual instrumentation devices in the software, the appearance of which is the same as of the real ones, allows to plan and conduct a wide range of experiments from training experiments to the study of real devices. This approach is an ideal tool for training, since it allows to remove almost all restrictions concerning the element base and instrumentation, as well as the problems associated with the possibility of incorrect actions of the experimenter.

The software package is of flexible structure. It contains a large number of models of radio electronic devices of the most known manufacturers, such as Motorola, Generic, Symmetry Design Systems, Texas Instruments, Maxim, Linear Technology, IIT, National Semiconductor, and also allows to supplement existing libraries with similar elements with the desired characteristics.

Knowledge and skills of the APP and CIT departments will be used for the design, setup and maintenance of electronic systems and biometric devices. This knowledge is used in measurement instruments developed by the APP and CIT departments.

As a part of the Tempus project "Desire", the learning process included the issues of studying microprocessor technology, which is the basis for creating medical software and automation of medical research. In the course of work, we got acquainted with the direction and results of the Emsys laboratory (Belgium), dedicated to the development of built-in computerized systems for controlling loads in implants of various purposes.

In the framework of the scientific work carried out by the CIT Department, research is being conducted on the use of new materials, namely titanium, for the production of implants for various purposes. In this direction, since 2015, scientific and technical cooperation with the «Motor Sich» company, producing implants, is developing, and they plan to use the findings of the CIT department in their production.

During the last 9 years, teachers and students of the CIT Department participate in the program of cooperation with Delcam and take part in competitions of students' scientific works. A number of diploma projects and masters' works have been completed, experience in designing specialized software for developing and manufacturing implants for various purposes has been accumulated. These are implants for maxillofacial surgery, for prosthetics in dentistry, spine implants. In particular, the students developed CAD implants and used PowerSHAPE and PowerMILL software to build implant models and manufacturing on CNC machines, built dental surfaces, implants, which are the basis for the installation of prostheses in the jaw. The software for designing bracket systems was also developed, not only creating a geometric model of the system with reference to the actual location of human teeth, but also finite element calculations in the CAE system for determining the forces acting on the teeth from the bracket system for excluding periodontal damage. A technology for designing geometries and calculations of blanks for obtaining spine implants with the use of plastic deformation in CAE-system was also developed.

At the CMS department a significant scientific and methodical material has been developed for the specialization "Production of medical equipment and tools", the first set of students was enlisted in 2016. In particular, the laboratory of technologies for strengthening and applying wear-resistant coatings has been working at the department for more than 25 years. Ion-plasma coating technologies have been studied for many years by students of the department.

The capabilities of the HEIDENHAIN Scientific and Innovation Center operating on the basis of the CMS department, as well as software for machining complex surfaces can be used for the development and implementation of innovative 3D milling technologies for orthopedic insoles for footwear.

The experience of designing modern mechatronic systems for various purposes, developed by the teachers of the department, creates a reliable basis for the development of high-tech mechatronic limb prostheses.

Within the specialization "Production of Medical Equipment and Tools", a fundamentally new training course "Generative Forming Technologies and 3D Prototyping" is created, the main task of which is to form a set of theoretical knowledge and practical skills for students to develop and implement modern 3D printing technologies of various medical products, including implants made from biocompatible materials.

The CMS department has close creative links with the scientists of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". It creates a foundation for the future use in the educational process of the department of technology and equipment for magnetic abrasive processing of surgical and dental instruments.

Trends in the development of specializations of medical appointment. To improve the quality of education and practical skills of students, a meeting was held with the administration of the Donetsk National Medical University.

For the organization of practices in 2018, programs have been developed for students of the CIT, APP and CMS departments, which set out the objectives of their conduct, the main tasks for students, the content of excursions and information that students must learn. This program is currently under negotiation.

Consent is received for students of the DSEA to conduct practice at the Sytenko Institute of Spine and Joint Pathology of National Ukrainian Academy of Medical Sciences (SISJP AMSU). For execution of these works, a four-side agreement has been concluded between the DSEA, ZNTU, SISJP AMSU and the «Motor Sich» plant, which produces implants for the lower limbs of a person. A cooperation program has been developed within the framework of the agreement, which is aimed at improving the educational process, as well as with the aim of carrying out joint scientific research.

Thus, the DSEA's CIT, APP and CMS departments created all the necessary conditions for educational work of specializations of medical appointment.

3. Prospects for project implementation

Introduction of specializations of medical appointment to the curricula of the DSEA promotes the development of the Academy, increases its competitiveness among technical higher education institutions, attracts new entrants.

Bachelor's training in medical specialties in the DSEA is carried out by the APP, CIT and CMS departments. First bachelor's degree students in medical specialization will graduate from the APP and CIT departments next academic year, and a year later – from the CMS department. Therefore, the following types of work on the development of specializations are topical:

- to develop and approve the programs of industrial practices (trial and technological practices) for specializations of medical appointment;
- to develop the subjects of course projects and diploma projects in the medical field;
- to develop and approve master's curricula with appropriate specializations in the medical field;
- to increase the effectiveness of career guidance work of the departments to promote the number of applicants specializing in medical field;
- to continue work on identifying the need for technician medical specialists for informational and technical maintenance of medical equipment of the region for their further training and employment.

Annex 1

Curriculum for the 2017-2018 academic year (Bachelor's degree)
APP department

№	Name of the discipline	Semester	Credits	Hours
1. MANDATORY EDUCATIONAL DISCIPLINES				
1.1. Humanitarian and socio-economic disciplines				
1	Foreign language (ESP)	1…4	6,5	195,0
2	History of Ukraine	1	3	90
3	History of Ukrainian Culture	4а	2,0	60
4	Ukrainian language (USP)	4а	3,0	90
5	Philosophy	4б	3	90
1.2. Disciplines of natural sciences (fundamental) training				
1	Ecology	4а	2	60
2	Engineering graphics	1	4	120
3	Computer technologies and programming	1…2	11,5	345
4	Higher mathematics	1…2	15,0	450
5	Introduction to the learning process	1	2	60
6	Probability theory, probabilistic processes and mathematical statistics	3	3,5	105
7	Physics	2…3	11,0	330
8	Chemistry	2а	2,5	75
1.3. Disciplines of professional training				
1	Automation of technological processes and production	6	4	120
2	Electronics and microprocessor technology	4	6	180
3	Electrical engineering and electromechanics	3	5	150
4	Identification and modeling of automation objects	7	4	120
5	Metrology, technological measurements	4	5,5	165

	and devices			
6	Basics of labor protection and life safety	3,6	3,5	105
7	Designing of automation systems	7…8	5	150
8	Automatic control theory	4…5	9	270
9	Technical means of automation	5…6	5	150
2. FREE ELECTION DISCIPLINES				
2.1. Social-humanitarian (optional) disciplines				
1	Foreign language	3…6	8	240
2.2 Natural sciences (fundamental) disciplines				
1	Entrepreneurship and business economics	7	3	90
2	Theoretical mechanics	2...3	6	180
2.3. Discipline of professional training				
1	Automation of industrial equipment	7	3	90
2	Automated electric drive	6…7	6	180
3	Executive mechanisms and regulatory bodies	5	3,5	105
4	Hydro-gas dynamics		3	90
5	Controllers and their software	6	6	180
6	Metal-cutting machine tools and equipment for automated production	5	3	90
7	Basics of computer-integrated management	8	7	210
8	Electric drive theory	5…6	6	180
9	CAD / CAM systems	5	3	90
10	Thermodynamics and heat engineering	8б	3	90
11	Technology of complex systems programming	7…8	7	210
Specialization Control systems and microcircuitry for biometric purposes				
1	Anatomy and physiology of man	1	1,5	45
2	Medical terminology and Latin language	2б	1,5	45

3	Ultrasonic equipment and technology	8б	2,5	75
4	Mathematical modeling of processes and biometric systems	6б	3	90
5	Computer technologies in medical and biology research	6а	3	90
6	Management of biotechnical systems	8а	3	90
7	Methods of mathematical processing of medical and biological data	6б	3	90
8	Computer tomography	8б	2,5	75
9	Biotechnical systems and technologies	4	3	90
10	Biomechanics	3	1,5	45
11	Nodes and elements of medical equipment	3	2	60
3. PRACTICAL TRAINING				
1	Computer practice	2б	2	60
2	Production practice	6б	3	90
3	Undergraduate practice	8а,8б	4	120
4	Certification	8б	7,5	225
4. STATE CERTIFICATION				
1	Protection of the diploma project	8б	1,5	45

Curriculum for the 2017-2018 academic year (Bachelor's degree)
CIT department

№	Name of the discipline	Semester	Credits	Hours
1. MANDATORY EDUCATIONAL DISCIPLINES				
1.1. Humanitarian and socio-economic disciplines				
1	Foreign language (ESP)	1…8а	6,5	195,0
2	History of Ukraine	1	3	90
3	History of Ukrainian Culture	4а	2,0	60
4	Ukrainian language (USP)	3	3,0	90
5	Philosophy	4б	3	90
1.2. Disciplines of natural sciences (fundamental) training				

1	Life Safety	4б	1,5	45
2	Basics of labor protection	6б	2,0	60
3	Introduction to the learning process	1	2,0	60
4	Discrete mathematics	1…2а	7,0	210
5	Ecology	4а	2,0	60
6	Economy and business	7	3,0	90
7	Mathematics	1…2б	12,0	360
8	Mathematical methods of operations research	5…6б	5,0	150
9	Theory of algorithms	2а…3	5,0	150
10	Probability theory, probabilistic processes and math. statistics	3	3,5	105
11	The theory of decision making	6а	3,0	90
12	Physics	2а,2б	6,0	180
1.3. Disciplines of general professional training				
1	WEB-technologies and WEB-design	6а, 6б	4,0	120
2	Algorithmization and programming	1	4,5	135
3	Algorithms on discrete structures	3	3,5	105
4	Intellectual data analysis	6а	3	90
5	Computer graphics and computer architecture	4б	3	90
6	Computer networks	4а, 4б	3	90
7	Cross-platform programming	8а	3	90
8	Methods and systems of artificial intelligence	7,8а	6	180
9	System simulation	8а, 8б	5,5	165
10	Object-oriented programming	2а,2б	5	150
11	Operating Systems	4а	3	90

12	Organization of databases and knowledge bases	5, 6а	4,5	135
13	Designing of information systems	8а,8б	3	90
14	Work with remote databases	7	3	90
15	System programming	4а	3,5	105
16	System analysis	5	3	90
17	Information security technologies	8а	3	90
18	Computer Design Technologies	6б,7,8а	1	30
19	Distributed systems and parallel computing technologies	7	5,5	165
20	Technology of creating software products	5,6а	6,5	195
21	IT project management	8б	3,5	105
2. FREE ELECTION DISCIPLINES				
2.1. Social-humanitarian (optional) disciplines				
1	Foreign language	3…6	8	240
2.2 Natural sciences (fundamental) disciplines				
1	Automated systems of scientific research	5	3	90
2	Probabilistic processes and mat. statistics in automated systems	5	3	90
3	Methods and means of CIT	6а	3	90
4	Geometrical modeling and designing of engineering objects	6б	3	90
5	Basics of automation of measurements with elements of Virtual Computer Experiment	6б	3	90
2.3 Disciplines of professional training				
1	Fundamentals of technical creativity and research	4б	2	60
2	Quality management and interchangeability	7	3	90
3	Physical foundations of modern semiconductor nanotechnologies	7	3	90
Specialization				
1	Anatomy and physiology of man	1	2,5	75
2	Design of parts and units of machines	6б,7	5,5	165
3	Technical mechanics (Biomechanics)	4б,5	5	150

4	Medical terminology and Latin language	2б	2	60
5	Electrical engineering and electronics	3,4а	4,5	135
6	Biotechnological systems and technologies	4б	4	120
3. PRACTICAL TRAINING				
1	Computer practice	2б	2	60
2	Production Practice (scientific research practice)	4б	2	60
3	Production practice (design and technology)	6б,7	3	90
4	Undergraduate practice	8а,8б	3,5	105
5	Certification design	8б	7	210
4. STATE CERTIFICATION				
1	Protection of the diploma project	8б	1,5	45