EDUCATIONAL-PROFESSIONAL PROGRAMME

«Bioinformatics and rehabilitation engineering»
of the first level of higher education

on specialty 163 Biomedical engineering

Branch of knowledge 16 Chemical and bioengineering

Qualification: Bachelor in Biomedical engineering

**Approved by Academic Council
of Ternopil Ivan Puluj national
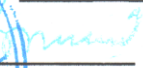technical university**

Head of Academic council   P.V. Yasniy

(Minutes № 11 of   17.11   2020)

Educational program is launched on « 01 »   09   2021 p.

Rector   / P.V. Yasniy

(order № 4/7-904 of « 01 »   12   2020)

**Ternopil
2020**

PREFACE

The Syllabus was developed by the working group (order № 4/7-658 of 21.09.2020) consisting of:

1. Yavorska Ye.B. – manager of the working group, Ph.D. in Engineering Science, Associate Prof., Head of the Bioengineering Systems Department of the Ternopil I.Puluj national technical university;
2. Khvostivskyy M.O. – Ph.D. in Engineering Science, Associate Prof. of the Bioengineering Systems Department of the Ternopil I.Puluj national technical university;
3. Dozorskyy V.H. – Ph.D. in Engineering Science, Associate Prof. of the Bioengineering Systems Department of the Ternopil I.Puluj national technical university;
4. Bachynskyy M.V. – manager of LLC «НВП Інфотехмед» (due to the agreement), Ph.D. in Engineering Science, Associate Prof.;
5. Shkurin Victor – student of group RBm-41.

Reviews of external stakeholders:

1. Blikhar V.Y., Chief Doctor of communal establishment of Ternopil regional council «Ternopil university hospital».
2. Kmita V.V, medical director on public health service of Ternopil communal city hospital №2.
3. Drosyk M.M., director of Western-Ukrainian specialized medical center «МЕВІЗ».

1. Bachelor's Training Program in Specialty №163 «Biomedical engineering»

1 – General information

Full name of higher educational establishment and a structural subdivision	Ternopil I.Puluj national technical university, Bioengineering Systems Department
Full name of qualification	Higher education degree - Bachelor Qualification – expert in Biomedical engineering
Program official name	Bioinformatics and rehabilitation engineering
Diploma type and number of credits according to the program	**Diploma type:** Bachelor's Diploma (Single Honours). **Number of credits according to the program**: - based on Complete general secondary education – 240 credits ECTS; - based on the degree «Junior Bachelor» (of educational-qualification level «Junior Specialist») a higher educational establishment is entitled to recognize and credit not more than 60 credits ECTS of the previous educational program of Junior Bachelor (Junior Specialist) training. The total amount of practice covers not less than 4 credits ECTS. Minimum 50% of the educational program credits must provide the acquiring general and special (professional) competences on specialty. **Duration of study:** 3 years 10 months.
Accreditation	MES of Ukraine, Certificate of accreditation НД № 2087407 of June 3, 2014, valid to July 1, 2024.
Cycle/level	FQ-EHEA – first cycle, EQF LLL – 6th level, HPK – 6th level
Requirements	Certificate of complete general secondary education or Junior Bachelor diploma.
Language(s) of instruction	Ukrainian, English
Accreditation	Till a new educational program is launched.
Permanent Internet address of educational program description	https://tntu.edu.ua/storage/pages/00000485/op163b-biri.pdf

2 - Purpose of the educational-professional program

Training of specialists able to solve practical problems and complex specialized tasks in Biomedical engineering characterized by complex and uncertain conditions.

3 – Characteristics of the educational-professional program

Subject area (branch of knowledge), specialty, specialization (if it is available)	Branch of knowledge - 16 Chemical and bioengineering Specialty - 163 Biomedical engineering
Educational program orientation	Educational-professional
Main focus of the educational program and specialization	**Study and (or) activity objects:** development, production, testing, експлуатація, servicing, repair and certification of medical equipment and biomedical products and biomaterials of medical use; biomedical information processing; technical-information support of medical technologies and systems. **Study goals:** be competent in the field of development, design, production, maintenance, service, expertise and certification of biological and medical instruments and systems, estimation of meeting the requirements of technical regulations, standards of biosecurity and biosafety of biological and medical equipment, biomedical products

	and biomaterials of medical use, artificial organs, and also the proper software and IT.
	Theoretical content of subject area: clinical engineering, medical equipment, microelectromechanical systems, medical radiology, medical biotechnologies, biomechanics, robots, biomedical informatics, decision making in medicine; reception, processing, interpretation of bio signals and images of biological objects.
	Methods and techniques: engineering-design methods, bioengineering and medical-engineering methods, modeling, software and information technologies for processing and analysis of biological data, medicine and medical instrument-making.
	Instruments and equipment: biological and medical equipment, biomedical products and biomaterials of medical use, artificial organs, IT-equipment.
Special features	Regular updating enabling to take into account the tendencies of progressing of medical, engineering, and information technologies development. It is mobile by the program of academic mobility «Double diplomas»

4 - Graduates suitability for employment and further education	
Suitability for employment	**Main positions according to SC 003:2010:** 3111 – expert in medical physics, 3115 – technician of equipment operation and repair, 3119 – engineering specification technician, 3119 – setup and test technician, 3133 – operator of medical equipment 3121 – expert in information technologies (medicine) 3118 – technician-designer **Main positions according to International Standard Classification of Occupations 2008 (ISCO-08):** 2149 – Engineer, biomedical 5329 – Assistant, medical imaging 2240 – Assistant, medical: diagnosing and treating patients 1342 – Administrator, medical 3255 – Assistant, allied health: physiotherapy 3255 – Assistant, technical: physiotherapy
Further study	Graduates can continue the study on the second (Master's) level of higher education. They can obtain some other qualifications in the system of post-graduate studies.

5 – – Teaching and Assessment	
Teaching and study	The process of study involves both conventional and non-conventional teaching methods, and advanced technologies as well. Conventional methods: lectures, practical and laboratory classes, tutorials; advanced technologies: student-centered study, self-study, problem-oriented study, study through the laboratory practice etc.
Assessment	Knowledge testing, presentations, reports on laboratory works, reports on practices, control papers, course (project) papers, oral and written examinations, qualification paper or attestation exam.

6 – Program competences	
Integral competence	Be able to solve practical problems and complex specialized tasks characterized by complex and uncertain conditions and involving the use of theories and methods of chemical, biological and medical

		engineering in the field of biomedical engineering or in the study process.
General competences (GC)		
	GC1.	Ability in applying theoretical knowledge in practice.
	GC2.	Knowledge and understanding the subject area and professional activity.
	GC3.	Be able to speak and write in state language.
	GC4.	Be able to apply information and communication technologies.
	GC5.	Be able to conduct research on proper level.
	GC6.	Be able to search, process and analyze information from different sources.
	GC7.	Be able to generate new ideas (creativity).
	GC8.	Be able to make reasonable decisions.
	GC9.	Be able to communicate with representatives of other professional groups of various levels (with experts in other fields of knowledge or economic activity).
	GC10.	Have skills of safe activity.
	GC11.	Be able to assess and assure the quality of the work done.
	GC12.	Be able to implement rights and duties as a member of society; comprehension of value of civil (free democratic) society and the necessity of its sustainable development, supremacy of law, human rights and freedoms in Ukraine.
	GC13.	Be able to store and add moral, cultural, scientific values and achievements of society due to the understanding of history and laws of development of the subject area, its place in the general system of knowledge about nature and society and in the development of the society, engineering and technologies, apply different kinds and forms of physical activity for active rest and healthy lifestyle.
Special (professional, subject area) competences (SC) Normative component	SC1.	Be able to use the engineering software aimed at scientific research conducting, results analysis, processing and presentation, and also at computer-aided design of medical devices and systems.
	SC2.	Be able to provide engineering-technical expertise in planning, development, assessment and specification of medical equipment.
	SC3.	Be able to master and apply new methods and tools of analysis, modeling, design and optimization of medical devices and systems.
	SC4.	Be able to provide technical and functional characteristics of systems and facilities used in medicine and biology (in disease prevention, diagnostics, treatment and rehabilitation).

	SC5.	Be able to use physical, chemical, biological and mathematical methods in analysis, modeling of living organisms and bioengineering systems functioning.
	SC6.	Ability in efficient using tools and methods of analysis, design, calculations and tests at the development of biomedical products and services.
	SC7.	Ability in planning, designing, developing, installing, applying, maintaining, servicing, controlling and repair coordinating the devices, equipment and systems for disease preventing, diagnostics, treatment and rehabilitation used in hospitals and scientific-research institutes.
	SC8.	Be able to carry out some research and observations on interaction of biological, natural and artificial systems (prosthetic devices, artificial organs etc.).
	SC9.	Be able to identify, set and solve some engineering problems dealing with interaction of living and nonliving systems.
	SC10.	Be able to apply principles of construction of modern automated control systems of medical devices manufacture, their engineering, algorithm, information and software support.
Special (professional, subject area) competences (SC) Optional component	SC11.	Be able to analyze, choose and apply methods and tools to develop Web-applications in medicine
	SC12.	Be able to analyze, develop architecture, modules and components of computer systems of medical use.
	SC13.	Ability to substantiate the choice, to analyze accuracy, to determine parameters by making experiments and to develop structural materials of biophysical quantities and electrodes transducers taking into account medical complexes and systems operational conditions
	SC14.	Be able to simulate a human body work due to combining mechanical devices, electronics and a biological organism.
	SC15.	Be able to provide information confidence, accessibility and completeness in the health care system.
	SC16.	Be able to apply computer3D-technologies in rehabilitation engineering.
	SC17.	Ability to design and use local and global computer networks to solve tasks of biomedical information transfer
	SC18.	Be able to understand specific features of biological systems as objects of study arranging and carrying out some medical experiments, experimental procedure, calculation ratio to calculate medical-biological indices.
	SC19.	Be able to develop and apply mobile medical devices and their software to solve applied and fundamental problems of biomedical engineering.
	SC20.	Be able to conduct functional, circuit and parameter synthesis of medical equipment.
	SC21.	Ability of development, optimization and modeling of artificial intelligence system in medicine

	SC22.	Ability to build functional networks of telemedicine systems and estimate their maximum capabilities whilst medical information exchange in telecommunication networks
7 – Program learning outcomes		
Normative component	PLO1.	Apply knowledge of fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering drawing, mechanics, material strength and resistance, fluid mechanics, electronics, informatics, signal and image receiving and analysis, automatic control, system analysis and methods of decision making on the level necessary to solve problems of biomedical engineering.
	PLO2	Come to logic conclusions and substantiated recommendations on assessment, use and implementation of biotechnical, medical-technical and bioengineering methods and facilities.
	PLO3	Manage complex actions or projects, take responsibility for engineering decisions making under unpredictable conditions.
	PLO4	Be able to apply statements of regulatory-technical documents specifying the procedure of product certification, production attestation.
	PLO5	Be able to use databases, mathematical and software support in data processing and computer modeling of bioengineering systems.
	PLO6	Be able to communicate with professionals in the field of health care in state and foreign (English or another EU official) languages and understand their requirements to biomedical products and services.
	PLO 7	Provide engineering support, servicing and other technical support at operation of laboratory-analytical equipment, medical diagnostic and therapeutic complexes and systems, be able to write standard documents of different types of work according to Technical regulation of medical products.
	PLO 8	Understand theoretical and practical approaches to development and control of medical equipment and facilities.
	PLO 9	Understand theoretical and practical approaches to development and use of artificial biological and bioengineering objects and materials of medical use.
	PLO10	Be able to plan, organize, direct and control medical-technical and bioengineering systems and processes.
	PLO11	Provide control of quality and operating conditions of medical equipment and materials of medical use, artificial organs and prosthetic devices.
	PLO12	Give recommendations on choosing the proper equipment used in diagnostics and treatment.
	PLO13	Be able to analyze signals transmitted from organs to the devices and process diagnostic information.

	PLO14	Be able to analyze the level of meeting the current global standards and to assess the decisions, set tasks on development of automated control systems taking into account possibilities of advanced software and hardware as for medical equipment automation.
	PLO15	Be able to set tasks on development of automated control systems taking into account possibilities of advanced software and hardware in medical equipment automation.
	PLO16	Have a skill in choosing and recommending the proper medical equipment and biomaterials to equip medical establishments and provide the main stages of technological process of diagnostics, disease prevention and treatment.
	PLO17	Be able to use computer-aided design systems to develop technological and hardware circuit of medical; devices and systems.
	PLO18	Apply knowledge of chemistry and bioengineering for development, synthesis and use of artificial bioengineering and biological objects.
Optional component	PLO19	Skill in development of web-oriented software in medicine.
	PLO20	Be able to substantiate configuration of personal computer to perform tasks of various complexity of medical use, be able to test a personal computer by software and hardware, estimate the possible functional use of personal computers architecture, assess the efficiency of personal computers use at different operating modes under operating system control conditions.
	PLO21	Knowledge of general principles of operation, functions and structure, use of biomedical sensors for medical complexes and systems.
	PLO22	Be able to combine mechanical devices, electronics and biological organisms for the problems of orthotics.
	PLO23	Be able to use system sand methods of software products, devices, computer networks security to provide confidence, accessibility and completeness of information in the health care system.
	PLO24	Be able to use computer3D-technologies to solve problems in rehabilitation engineering.
	PLO25	Knowledge of computer networks construction principles, peculiarities of traditional and advanced technologies of local and global networks, ways of complex networks development, ways of computer networks control, and ways of biomedical information transfer in computer networks
	PLO26	Be able to choose a proper research method according to the specific medical problem, experiment environment, available hardware, staff training level and calculate methods-biological indices.

	PLO27	Knowledge of design tools and technologies of mobile medical devices, their software on different mobile operating systems (platforms)
	PLO28	Be able to apply mathematical apparatus and hardware to construct medical equipment.
	PLO29	Knowledge of modern principles of construction of mathematical, software, linguistic, technical and information support of artificial intelligence systems in medicine.
	PLO30	Knowledge of fundamentals of telemedicine, telemedicine systems and methods of medical information processing in telemedicine systems

8 – Program implementation resources	
Staff assistance	All academic staff involved in the profession-oriented courses teaching has scientific degrees and/or academic status and they meet the license requirements. The program meets the requirements of staff assistance in educational activity assurance in the field of higher education concerning the educational level "Bachelor" according to the current laws of Ukraine (Statement of Cabinet of Ministers of Ukraine of 30.12.2015 № 1187 amended in 23.05.2018 № 347).
Materials and facilities	Materials and facilities of the Bioengineering systems Department are a part of the material-technical base of the Faculty of Applied Information Technologies and Electrical Engineering of TNTU. All laboratory and practical classes of non-professional courses are delivered in the classroom fund and material-technical base of the university. Professional laboratory and practical classes are given in special laboratories of the Bioengineering systems Department in building №9 of TNTU named after Ivan Puluj.
Information support and teaching – learning materials	Use of virtual learning environment of TNTU, author's papers of the academic staff, library-information resources, resources of the scientific-technical library of the university. The e-learning system ATutor provides an access to the materials in English and Ukrainian within the educational program, presentations, tests, video material, other components of e-learning. The platform ATutor has been developed for distance access to the teaching-learning materials which combines materials of lectures, practical classes, instructions and tasks to self-study with possible team work in e-learning courses, materials of e-catalogue of the library, repository and references on external learning courses.

9 – Academic mobility	
National credit mobility	Agreements of academic mobility, of double diplomas awarding have been signed
International credit mobility	In 20016 some new agreements of cooperation have been signed with: Lublin University of technology (Poland); Opole University of technology (Poland); Jan Amos Komienski State school of higher vocational education (Poland); Shota Rustaveli Batumi state university (Georgia); Sopot high school (Poland); Czestochowa University of technology (Poland); Company "Television communications" (Lithuania); Company "II Autoezeruona" (Lithuania); Kaunas University of technology (Lithuania); Gabrovo technical university (Bulgaria); Wroclaw university of economics (Poland); University of

	Informatics and Applied Knowledge in Łód. (Poland); University of Zylina (Slovak Republic).
	Participation in the international program of EU Horizont 2020 and international educational programs of EU Tempus / Erasmus+
Foreign students training	Main course modules of the program are provided with educational and methodical complex for foreign students both in English and Ukrainian.

2. List of EPP educational components and their logical sequence

1.1. **List of educational components**

Code n/a	Components of the educational program (academic disciplines, course projects (works), practices, qualification works)	Number of credits	Form of final control
1	2	3	4
Mandatory components of the educational program			
RC1	Higher Mathematics	13,5	Examination
RC2	General chemistry	4	Examination
RC3	Language of Instruction (English)	6	Examination
RC4	History and Culture of Ukraine	5	Examination
RC5	Technoecology and Civil Safety	4	Credit
RC6	Ukrainian for Specific Purposes	5	Examination
RC7	Physics	12,5	Examination
RC8	Physical Education	0	-
RC9	Philosophy	4	Examination
RC10	Human Anatomy, Physiology and Pathology	7	Credit
RC11	Medical Databases	4	Credit
RC12	Life Safety and Fundamentals of Labor Protection	4	Examination
RC13	Biomedical Engineering	4	Examination
RC14	Medical Devices Design	4	Examination
RC15	Electronics in Medicine	12	Examination
RC16	Engineering Support for Medical Technology	4	Credit
RC17	Medical Images Computer Processing	4	Examination
RC18	Computer Processing of Biomedical Signals and Data	5	Examination, Coursework
RC19	Mathematical and Computer Modelling of Medical Equipment	5	Examination, Coursework
RC20	Materials Science and Biocompatibility of Materials	4	Credit
RC21	Medical Devices, Complexes and Systems	4	Examination
RC22	Microprocessors in Medicine	4	Examination
RC23	Biomedical Processes and Signal Modelling	5	Examination, Coursework
RC24	Biophysics and Biomechanics Fundamentals	4	Credit
RC25	Fundamentals of Clinical Medicine	4	Credit
RC26	Programming and Algorithmic Languages	4	Credit
RC27	Rehabilitation Engineering	4	Examination
RC28	Computer Aided Design Systems of Medical Devices	4	Credit
RC29	System Analysis and Decision Making in Medicine	4	Examination
RC30	Medical Devices Standardization and Certification	4	Credit
RC31	Medical Device Manufacturing Technologies	4	Examination
RC32	Practical Training	3	Differentiated credit
RC33	Engineering and Production Practical Training	3	Differentiated credit
RC34	Industrial Internship	3	Differentiated credit
RC35	Professional practice	7,5	Differentiated credit
RC36	Qualification paper	1,5	
The total amount of mandatory components		**174**	

1	2	3	4
Selective components of the educational program are recommended		
SC1	Medical Web Technologies	4	Credit
SC2	Computer Architecture	5	Credit
SC3	Biomedical Sensors	4	Examination
SC4	Biomechatronics	4	Examination
SC5	Іноземна мова професійного спрямування	10	Examination
SC6	Cybersecurity in Healthcare	4	Credit
SC7	Computer 3D Technologies in Rehabilitation Engineering	4	Examination, Coursework
SC8	Computer Networks in Medicine	5,5	Examination, Coursework
SC9	Medical and Biological Research	4	Credit
SC10	Mobile Devices in Medicine	5	Credit
SC11	Fundamentals of Construction Medical Technique	5,5	Examination, Coursework
SC12	Fundamentals of Law	3	Credit
SC13	Artificial Intelligence in Medicine	4	Examination, Coursework
SC14	Telemedicine Technologies	4	Credit
The total amount of sample components		**66**	
TOTAL VOLUME OF THE EDUCATIONAL PROGRAM		**240**	

2.2. Structural and logical scheme of the educational program

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8
Technoecology and Civil Safety	Philosophy	Ukrainian for Specific Purposes	Ukrainian for Specific Purposes	Ukrainian for Specific Purposes			
Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)	Language of Instruction (English)
History and Culture of Ukraine	History and Culture of Ukraine			Fundamentals of Law			
Higher Mathematics	Higher Mathematics	Higher Mathematics	Computer Aided Design Systems of Medical Devices	Biophysics and Biomechanics Fundamentals	Life Safety and Fundamentals of Labor Protection		
Physics	Physics	Physics	Medical Devices Standardization and Certification	Human Anatomy, Physiology and Pathology	Human Anatomy, Physiology and Pathology	Fundamentals of Clinical Medicine	
General chemistry	Electronics in Medicine	Electronics in Medicine	Electronics in Medicine	Computer Processing of Biomedical Signals and Data	Computer Processing of Biomedical Signals and Data	Medical Images Computer Processing	Engineering Support for Medical Technology
	Materials Science and Biocompatibility of Materials	Biomedical Engineering	Microprocessors in Medicine		Medical Databases	System Analysis and Decision Making in Medicine	Mathematical and Computer Modelling of Medical Equipment
		Programming and Algorithmic Languages	Computer Architecture	Biomedical Sensors	Rehabilitation Engineering	Medical Device Manufacturing Technologies	Medical Devices Design
				Medical and Biological Research	Biomechatronics	Fundamentals of Construction Medical Technique	Medical Devices, Complexes and Systems
					Artificial Intelligence in Medicine	Computer 3D Technologies in Rehabilitation Engineering	Computer Networks in Medicine
					Mobile Devices in Medicine	Telemedicine Technologies	Medical Web Technologies
							Cybersecurity in Healthcare
	Practical Training		Industrial Internship	Professional practice	Engineering and Production Practical Training		Qualification paper

Marking - **MANDATORY COMPONENTS** | **SELECTED COMPONENTS**

3. Form of attestation

Forms of Bachelor's attestation	The attestation of the students majoring in 163 Biomedical engineering is in the form of public defense of Qualification paper.
Requirements to the Qualification paper	Qualification paper must involve solving of a complex special engineering-technical task or a practical problem in the field of biomedical engineering characterized by complex and uncertain conditions and using theories and methods of chemical, biological and medical engineering. Qualification paper must not contain any academic plagiarism, fabrication, falsification. Qualification paper should be released on the official site and/or in the repository of the higher education institution or its subdivision. Making Qualification papers containing some information of restricted access available to the public must meet the requirements of the current law.

4. Matrix of accordance of program competences to educational program components

The table below maps program competences (rows) to the Components of the educational and professional program (columns). Columns EC1–EC36 are the **Mandatory components of the educational and professional program**; columns SC1–SC14 are the **Recommended selective components of the educational-professional program**. An asterisk (*) marks accordance.

Competences	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10	EC11	EC12	EC13	EC14	EC15	EC16	EC17	EC18	EC19	EC20	EC21	EC22	EC23	EC24	EC25	EC26	EC27	EC28	EC29	EC30	EC31	EC32	EC33	EC34	EC35	EC36	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14
Integral	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC1																	*				*																	*		*	*	*	*	*						
GC2										*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC3				*																																	*													
GC4																*	*	*			*	*		*													*		*	*				*	*	*		*		*
GC5						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC6						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC7						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC8						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC9		*				*			*																												*								*					
GC10											*						*				*																*													
GC11										*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
GC12			*	*										*														*		*							*												*	
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SC5	*	*				*											*	*	*				*	*	*																									
SC6											*			*	*		*	*	*				*	*							*	*					*		*	*			*	*			*	*	*	*
SC7																*					*					*		*															*	*		*				*
SC8						*														*			*			*																		*	*					
SC9																				*			*			*																		*	*					
SC10																														*			*																	
SC11																									*												*													
SC12																																						*												

| Competences | Components of the educational and professional program | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Mandatory components of the educational and professional program | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Recommended selective components of the educational-professional program | | | | | | | | | | | | | |
	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10	EC11	EC12	EC13	EC14	EC15	EC16	EC17	EC18	EC19	EC20	EC21	EC22	EC23	EC24	EC25	EC26	EC27	EC28	EC29	EC30	EC31	EC32	EC33	EC34	EC35	EC36	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14
SC13														*						*																			*											
SC14															*									*																*										
SC15																																										*		*				*+		*
SC16																																											*							
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SC20	*														*																							*										*		
SC21																	*											*																					*	
SC22																																					*	*												*

5. Matrix of accordance of learning outcomes specified by the standards to educational program components

Components of the educational and professional program

Mandatory components of the educational and professional program: EC1–EC36 (with OK10). Recommended selective components of the educational-professional program: SC1–SC14.

Program learning outcomes (PLO)	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	OK10	EC11	EC12	EC13	EC14	EC15	EC16	EC17	EC18	EC19	EC20	EC21	EC22	EC23	EC24	EC25	EC26	EC27	EC28	EC29	EC30	EC31	EC32	EC33	EC34	EC35	EC36	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14
PLO1	*	*					*				*			*	*		*	*		*	*	*	*	*		*		*	*			*	*	*	*	*	*	*	*			*	*	*		*			*	
PLO2											*		*			*					*				*					*		*	*	*	*	*									*					
PLO3																*														*		*	*	*	*	*														
PLO4																														*	*	*	*	*	*	*														
PLO5											*					*	*	*	*													*	*	*	*	*														
PLO6			*		*	*										*										*		*				*	*	*	*	*														
PLO7																*					*									*		*	*	*	*	*														
PLO8													*	*	*					*	*					*			*		*	*	*	*	*	*				*			*				*	*	*	*
PLO9																					*					*						*	*	*	*	*				*			*							
PLO10																*					*			*		*						*	*	*	*	*											*			
PLO11																*				*	*					*				*		*	*	*	*	*														
PLO12											*					*					*					*						*	*	*	*	*														
PLO13																	*	*														*	*	*	*	*														
PLO14													*													*			*			*	*	*	*	*							*					*		
PLO15													*													*			*			*	*	*	*	*							*					*		
PLO16											*					*				*	*					*						*	*	*	*	*				*								*		*
PLO17																												*			*	*	*	*	*	*														
PLO18		*											*													*						*	*	*	*	*									*					
PLO19																														*		*	*	*	*	*	*													
PLO20																																*	*	*	*	*				*										
PLO21																				*												*	*	*	*	*					*									
PLO22															*									*								*	*	*	*	*								*						
PLO23																																*	*	*	*	*							*		*			*		*
PLO24																										*						*	*	*	*	*									*					
PLO25																																*	*	*	*	*				*							*			

Components of the educational and professional program

Program learning outcomes (PLO)	OK1	OK2	OK3	OK4	OK5	OK6	OK7	OK8	OK9	OK10	OK11	OK12	OK13	OK14	OK15	OK16	OK17	OK18	OK19	OK20	OK21	OK22	OK23	OK24	OK25	OK26	OK27	OK28	OK29	OK30	OK31	OK32	OK33	OK34	OK35	OK36	BK1	BK2	BK3	BK4	BK5	BK6	BK7	BK8	BK9	BK10	BK11	BK12	BK13	BK14
PLO26																			*						*							*	*	*	*	*									*					
PLO27																										*						*	*	*	*	*									*					
PLO28	*														*																	*	*	*	*	*			*										*	
PLO29																	*												*			*	*	*	*	*													*	
PLO30																																*	*	*	*	*		*	*											*

Requirements for the internal quality assurance system of higher education

Requirements for internal quality assurance of higher education are regulated by a separate regulation of TNTU - Quality Management System (QMS).

Strategic Management of the University (order №4 / 7-568 of 25.07.2016, https://docs.tntu.edu.ua/base/document?id=24).

According to the decision of the Certification Body, on August 31, 2017, Ternopil Ivan Puluj National Technical University received certificates confirming compliance of the quality management system with the requirements of the international standard ISO 9001: 2015.

The first two certificates in Ukrainian and German were issued by the German certification body DQS GmbH, which is among the top three certification bodies in the world, which testifies to the international recognition of the quality of educational activities (certificate issued on 31.08.2018, valid until 30.08.2021, http://tntu.edu.ua/storage/pages/00000287/QM15_31400225_QM15_UK.pdf).

Another certificate of the single international standard IQNet (issued on 31.08.2018, valid - until 30.08.2021, registration number DE-31400225 QM15, http://tntu.edu.ua/storage/pages/00000287/IQNet_31400225_QM15_EN.pdf) issued by an international certification network (headquartered in Bern, Switzerland), which brings together 37 leading certification bodies in 34 countries.

The Ternopil Ivan Puluj National Technical University has a system of quality assurance of educational activities and quality of higher education (internal quality assurance system), which provides for the implementation of the following procedures and measures:

1) definition of principles and procedures for ensuring the quality of higher education;

2) monitoring and periodic review of educational programs; annual evaluation of higher education seekers, research and teaching staff of the higher education institution and regular publication of the results of such evaluations on the official website of the higher education institution, on information stands and in any other way;

3) providing advanced training of pedagogical, scientific and scientific-pedagogical workers;

4) ensuring the availability of necessary resources for the organization of the educational process, including independent work of students, for each educational program;

5) ensuring the availability of information systems for effective management of the educational process;

6) ensuring publicity of information about educational programs, degrees of higher education and qualifications;

7) ensuring an effective system for preventing and detecting academic plagiarism in the scientific works of employees of higher education institutions and applicants for higher education;

8) other procedures and measures.

Ternopil Ivan Puluj National Technical University ensures the quality of educational activities and the quality of higher education (internal quality assurance system) at the request of Ternopil Ivan Puluj National Technical University is evaluated by the National Agency for Higher Education Quality Assurance or its accredited independent institutions on its compliance with the requirements for the quality assurance

system of higher education approved by the National Agency for Quality Assurance in Higher Education and international standards and recommendations for quality assurance in higher education.

Guarantor of educational program,
Sc.D., Prof. of the Radio Systems Department   Bohdan YAVORSKYY

Ph.D. in Engineering Science, Associate Prof.,
Head of the Bioengineering Systems Department   Yevheniia YAVORSKA

Ph.D. in Engineering Science,
Associate Prof. of the Bioengineering Systems Department   Mykola KHVOSTIVSKYY

Ph.D. in Engineering Science,
Associate Prof. of the Bioengineering Systems Department   Vasyl DOZORSKYY

Chairman of the Expert Council of Employers of
Biotechnical Systems Department by specialty
163 "Biomedical Engineering"
of Ternopil Ivan Puluj National Technical University   Volodymyr KORDIAK

Student of group RBm-41   Victor SHKURIN

The list of normative documents on which the OPP is based

1. Standards and guidelines for quality assurance in the European higher education area (ESG). URL: https://enqa.eu/index.php/home/esg/. Україномовна версія: Стандарти і рекомендації щодо забезпечення якості в Європейському просторі вищої освіти. URL: https://enqa.eu/indirme/esg/ESG%20in%20Ukrainian_by%20the%20British%20Council.pdf.

2. Tuning Educational Structures in Europe, TUNING project. URL: http://www.unideusto.org/tuningeu/. Україномовна версія: Проект Європейської Комісії «Гармонізація освітніх структур в Європі». URL: https://www.unideusto.org/tuningeu/images/stories/documents/General_Brochure_Ukrainian_version.pdf.

3. Про вищу освіту: Закон України від 01.07.2014 р. № 1556-VII. *Відомості Верховної Ради України*. URL: http://zakon4.rada.gov.ua/laws/show/1556-18.

4. Про освіту: Закон України від 05.09.2017 р. № 2145-VIII. *Відомості Верховної Ради України.* URL: http://zakon5.rada.gov.ua/laws/show/2145-19

5. Про затвердження переліку галузей знань і спеціальностей, за якими здійснюється підготовка здобувачів вищої освіти: Постанова Кабінету Міністрів України від 29.04.2015 р. № 266. URL: http://zakon4.rada.gov.ua/laws/show/266-2015-п

6. Про затвердження Національної рамки кваліфікацій : Постанова Кабінету Міністрів України від 23 листопада 2011 р. № 1341. URL: http://zakon4.rada.gov.ua/laws/show/1341-2011-п (в редакції постанови Кабінету Міністрів України від 25 червня 2020 р. №519)

7. Класифікатор професій ДК 003:2010: Національний класифікатор України. *Держспоживстандарт України* ; Наказ від *28.07.2010* № 327. URL: https://zakon.rada.gov.ua/rada/show/va327609-10#Text.

8. Рашкевич Ю.М. Болонський процес та нова парадигма вищої освіти: монографія. Львів : Видавництво Львівської Політехніки, 2014. 168 с.

9. Стандарт вищої освіти другого (магістерського) рівня галузі знань 15 «Автоматизація та приладобудування», спеціальності 151 «Автоматизація та комп'ютерно-інтегровані технології», затверджений та введений у дію наказом Міністерства освіти і науки України від 10.08.2020 р. № 1022.

10. Положення про порядок розроблення, затвердження, моніторингу та припинення освітніх програм Тернопільського національного технічного університету імені Івана Пулюя – наказ №4/7-965 від 01.11.2019 зі змінами від 18.09.2020 – наказ №4/7-668 від 25.09.2020. URL: https://docs.tntu.edu.ua/base/document?id=466.